THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XIII.—No. 300.

RIVAL TELEGRAPH COMPANIES.

IN our list of companies' meetings we append a report of the first annual meeting of the Electric News Telegraph Company, which took place on the 20th inst. We notice that they have not been so successful in their working profits as we should have wished to have seen. The reason for this, as pointed out by the chairman, is not far to seek. At the present time there exist two rival companies—the Electric News Telegraph Company and the Exchange Telegraph Company—who supply Stock Exchange quotations, Parliamentary, general, and sporting news by means of automatic electric printing instruments, whereby subscribers may have, at their houses, the latest information delivered to them, printed automatically on a continuous band of paper. We gave a description, some time ago, of the apparatus employed by the Electric News Telegraph Company—the simplicity of which and rapidity of its action leave nothing to be desired. The Exchange Telegraph Company, who, until lately, had confined themselves to Stock Exchange quotations, on the formation of the Electric News Telegraph Company, were naturally somewhat irate; and since then, judging from the chairman's remarks, have been pursuing a most suicidal policy in their endeavours to sit upon the younger company, leaving no stone unturned to attain this object. Although no one can object to honest competition, it certainly appears to us that the course adopted by the Exchange Company towards the Electric News Telegraph Company is hardly what we should have expected from a company with such pretensions. If we remember rightly, when the prospectus of the Electric News Telegraph Company was first issued, advertisements were at the same time inserted by the Exchange Telegraph Company, endeavouring to dissuade intending investors from placing money in the new company, pointing out various parts of the apparatus as being worthless and unreliable. It is, however, remarked as a curious fact that, since then, the Exchange Company have copied in their instruments all these points formerly decried by them.

We have not seen a printed report of the meeting of the Exchange Company, referred to by Sir Michael Kennedy, as this appears to have been held with closed doors; but if, as stated by the chairman, in the year's work the Exchange Company sustained a loss of some £10,000, including the loss from subscribers giving up their instruments, we may congratulate the Electric News Telegraph Company on having a promising undertaking, as whilst they in a year have more than doubled their subscribers, the other company has, on the contrary, lost considerably.

It seems a pity that between these two rival companies there should exist such war-to-the-knife, surely some working arrangement could be arrived at that would prove beneficial to both.

ELECTRICAL RAILWAYS.

THE description we give this week of the electrical railway recently in operation at the Chicago Exhibition of railway appliances, will, no doubt, be read with interest. In America the subject has not apparently been investigated to the same extent as in England and parts of Europe, and this is rather to be wondered at when we consider how much more has been accomplished on the other side of the Atlantic in electric lighting matters. That such methods of locomotion will in any way seriously interfere with our present mode of employing steam-power we do not believe, any more than that the general introduction of the electric light would cause a diminution in the consumption of gas; but we do think that in several existing instances electricity might beneficially take the place of steam, and be employed in innumerable cases not yet entertained. Passengers, the whole world over, must be conveyed by some means or other from place to place, and surely in many parts of England short lines could be laid down and profitably worked.

It has often been urged that the weight of the locomotive can be reduced many times by the employment of electricity; but, on the other hand, the great weight of a steam locomotive is positively necessary to obtain a grip on the rails when drawing a heavily-loaded train. Our ordinary locomotives again, carrying their own fuel, can exert their maximum power wherever necessary: this cannot, however, be accomplished on an electrical railway, where the power is supplied from a fixed point. With secondary batteries, of course, such a result would be possible. It is, however, premature to speculate on what can or what cannot be accomplished in this direction, and we must therefore patiently await the outcome of enterprise.

So much capital has been literally thrown away on electric lighting that at the present time, it is exceedingly difficult to find capitalists with sufficient faith and courage to finance anything electrical. Electrical railways and the electrical transmission of power appear to us promising subjects for both inventors and capitalists, and were the same amount of talent and energy devoted to the development of these as was expended last year in electric lighting, we venture to say that a more profitable return to shareholders would be the result.

A NEW UNDERGROUND SYSTEM.

IN the electric era in which we are now living, one of the questions which is at present agitating the minds of the communities in our larger cities, is how to bury the network of wires which now obstructs our highways, defacing our buildings, and, in many instances, almost shutting off the sunlight from our houses.

Owing to the numerous objections offered by the various telephone, telegraph, and electric light companies against underground wires, there has, as yet, been but few practical steps taken towards this end, although systems almost innumerable have been presented, varying greatly in style of construction and in point of practical working. We place before our readers one of the latest plans for underground conduits, owned by the Continental Underground Cable Company of Camden, N. J.

The company intends placing electric light, telephone, and telegraph wires in the same plant, free from induction and retardation, and in the case of the electric light to do away with the loss in current, which has, up to the present time, been the one great objection to placing these wires underground.

The conduit consists of a series of semi-circular galvanised sheet iron troughs, or pockets, in sections of suitable length, supported by a framework of iron arms, cast to an upright, the different sections of which are bolted together, forming a smooth continuous line of pockets from one manhole to the next. The smooth surface of the pockets preventing injury to a single wire or cable while it is being drawn into position.

After laying this skeleton shelving on a suitable foundation of brick or cement, it is built in with blocks of asphalt compound, made by an improved process, whereby it becomes impervious to moisture and possesses great strength.

An earth connection is made with the metal pockets every few yards, serving to carry off the induced currents which would otherwise escape to surrounding wires. The cables are laid in the conduits by means of a small spring or electric motor, travelling between the manholes on an iron track within the conduit. The

motor first carrying through a small rope, and by means of an adjustible arm laying it in the pockets through which the cable is to be drawn, the rope afterwards serving to haul the cable in place.

Fig. 1 represents the pockets of galvanised sheet iron, and fig. 2 the cast-iron arms, and mode of fasten-

FIG. 1.

ing the sections together after the pockets are in place. Fig. 3 shows a small conduit suitable for branch streets, and fig. 4 a main line conduit, adapted for from one to six electrical companies, the troughs being arranged in sets of six, with the motor, C, running on

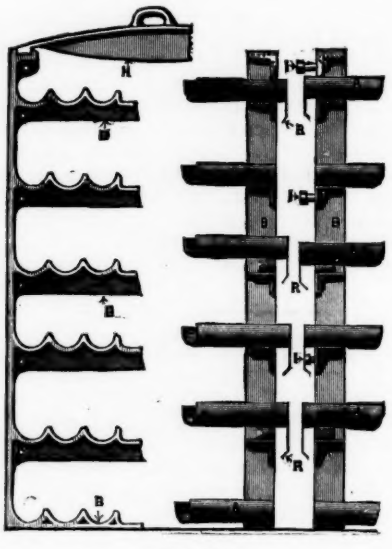


FIG. 2.

its track in the centre; each trough having a capacity for 200 wires.

The electric light system of this company has a novel feature—that of keeping the air within the conduit under a constant pressure and free from moisture, by passing it through a chemical dryer before pumping it into the conduit.

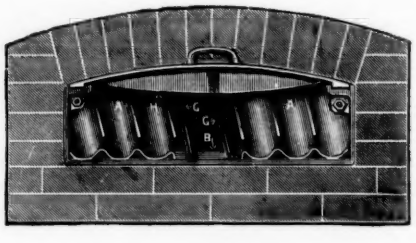


FIG. 3.

Figs. 5 and 6 represent end sections of conduits for electric lighting purposes, in which B are the conductors and A the metal pipe, the conductors being supported by suitable insulators within the pipe. The councils of Philadelphia, with a practically unanimous vote, passed an ordinance, which was approved by the Mayor on July 7th, authorising this company to lay its conduits under the principal streets of the city, and it is the intention of the company to be able, in the course of a very few months, to demonstrate the feasibility of the system. The plan seems to meet with much favour, and not a few are loud in their declarations that it is the coming system for laying wires underground.

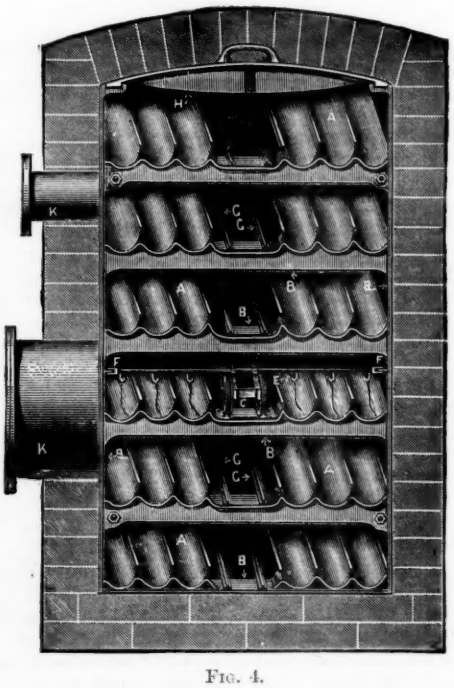


FIG. 4.

FIG. 5.

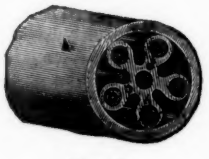


FIG. 6.

[We are indebted to the *Electrician* of New York for advanced proofs and illustrations of this article.—EDS. ELEC. REV.]

THE ELECTRIC RAILWAY AT THE CHICAGO EXHIBITION.

THE electric railway which was in operation at the recent exhibition of railway appliances at Chicago, constituted the leading novelty and one of the chief features of attraction.

When the remarkably short time in which this electric railway was constructed and put in operation is considered, it seems like a great achievement. The Electric Railway Company of the United States, which was formed to acquire and consolidate the Field and Edison patents, did not properly come into existence until about the beginning of May. The project of exhibiting at the Chicago Exhibition had been entertained, but it was not until two weeks before the opening that it was definitely decided that the electric railway should form one of its features. Everything remained to be prepared. The locomotive was scarcely begun, and the track was not laid. But the work was put under way and pushed with vigour. It is needless to say that the electric railway, under the circumstances, does not fairly represent the inventions of Messrs. Field and Edison, because the short time allowed to complete preparations left no other alternative than to make use of such electrical apparatus and material as could be readily and conveniently procured in the market without stopping to inquire too closely into its fitness for the purpose, and then to

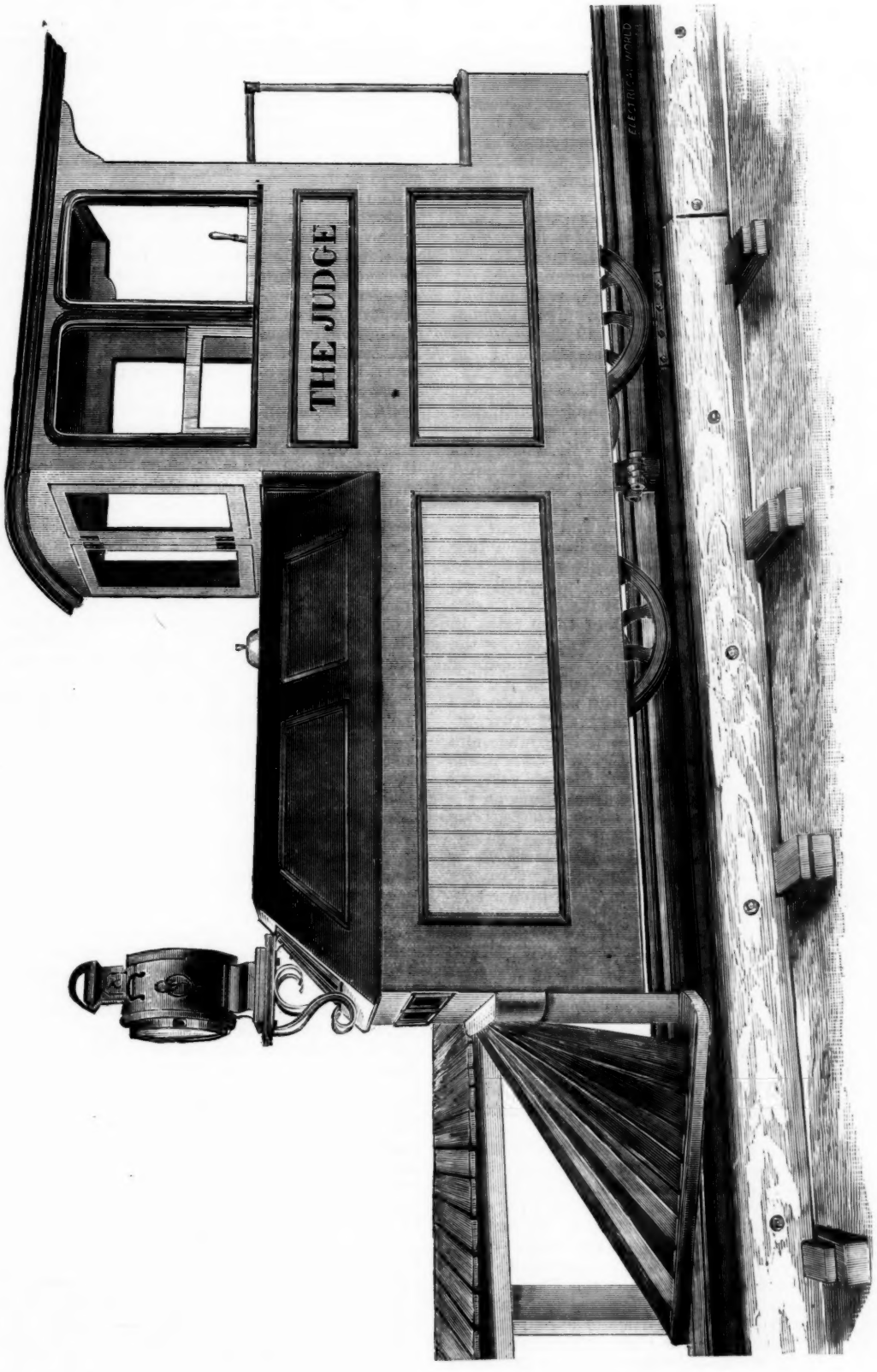


FIG. 1.

design everything else to suit its electrical and mechanical peculiarities. Under the circumstances, it was impossible to hope for great efficiency or economy of results. It is, indeed, a matter of surprise that an electric railway was produced at all from the resources available in that time, and it reflects the greatest credit upon Mr. Frank B. Rae, one of the electrical engineers of the company, who had charge of the enterprise, and Mr. Clarence L. Healy, his assistant, who personally attended to many details.

As the short time did not permit of the construction of dynamo-electric machines especially adapted to perform the functions of generator and motor, some Weston machines were procured for this purpose from the United States Electric Lighting Company, of New York. The same type of machine was used as generator and as motor. It was what is known as the No. 6 Weston 100 incandescent light machine, having an electromotive force of about 75 volts at its normal speed of 1,100 revolutions, and producing a current of about 150 ampères through its normal circuit resistance of 0.5 ohm. Its weight was 2,700 lbs. This electromotive force was comparatively low, and it was necessary to use great care to make the resistance of the track and connections a minimum.

Fig 1 represents the electric locomotive "The Judge" upon the track. The passenger car, which was similar in appearance to an open street car, is not shown. The locomotive was styled "The Judge" by Mr. Field himself, who claimed the privilege of baptising this child of his genius, in honour of his uncle, Chief Justice Field.

The track (fig. 2) on which "The Judge" ran was laid in the gallery of the main building, extending around its margin, and curving sharply at either end on a radius of 66 feet. Its total length was 1,553 feet, or nearly one-third of a mile. This track, which was of three-foot gauge, was composed of three rails, in accordance with Mr. Field's method of conveying the current to the motor of the locomotive. The middle or central rail was connected with one pole of the stationary generator located below on the main floor, at a distance of about 50 feet from the track. The two outside tracks were electrically connected together and with the other pole of the generator, as shown in the figure. This arrangement obviated the necessity of insulating the wheels on one side from those on the other.

The method of Mr. Field presents peculiar advantages, for it enables the electric locomotive to be adapted with little trouble to existing railroads.

In order to secure a low resistance and proper connections between all the rails, a precaution made necessary by the low electromotive force of the generator, wires were laid under each rail. The inside rail was wired with No. 6 bare copper wire, and the outside rail with No. 8 iron wire. The central rail was also wired with No. 8 copper wire. A good contact was made with each rail by proper fastenings at the joints and also by laying the wire under the rails in the supporting plates, so that the weight of the rail rested upon it. These precautions practically reduced the resistance of the line to a value so small as to be inconsequential.

The internal construction of the locomotive will be readily understood from the accompanying figures (3, 4, 5, 6). Fig. 3 shows the mechanism of the locomotive in side elevation. Fig. 4 is a plan view of the same. These figures show the manner of transmitting the power from the armature of the motor to the driving wheels. The motor is placed crosswise upon the frame. Its armature shaft is coupled to an extension shaft which is prolonged forward and transmits motion by means of bevel gearing to a counter-shaft carrying two pulleys. From these pulleys the power is transmitted by means of belts to the loose pulleys on the axle of the drivers. It will be noticed that this arrangement throws the greatest weight directly over the driving wheels. The gearing up of the armature extension-shaft to the counter-shaft was made so as to reduce the speed three times. The pulleys on the counter-shaft were 12 inches in diameter, the driven or loose pulleys on the axle of the drivers were 26 inches in diameter, and the car wheels, or drivers, were 30 inches in diameter. The maximum speed which this gearing would produce was about 12 miles per hour, but the weakness of the gallery upon which the track was laid made it necessary to run the locomotive at a lower speed. The average speed maintained was eight miles an hour, the motor revolving at the rate of about 750 turns.

Before proceeding further with the description it will be of interest and assistance to analyse briefly certain electrical conditions which rendered necessary the use of some of the mechanical devices which are yet to be described.

The two Weston machines used as generator and motor were of the "shunt wound" description, in which the current from the armature divides into two portions, one passing through the field-magnet circuit and the other through the external circuit, the amount of current apportioned to each circuit being inversely proportioned to its resistance. When the resistance of the external circuit is great, a larger amount of current passes through the field-magnet, and the magnetic field is made stronger. In this case the effect of opening the external circuit is precisely the same as if its resistance were increased to infinity; that is to say, all the current passes through the field-magnets and the magnetic field attains its highest degree of power. On the other hand, when the resistance of the external circuit is reduced to almost nothing, the largest proportion of the current passes through the external circuit, leaving only a small portion to pass through the field-magnets, and the magnetic field is very weak. Consequently, if we start a shunt generator with a closed external circuit of very low resistance, the small quantity of current induced in the armature by the residual magnetism of the magnetic field passes almost all into the external circuit, and the magnetism of the magnetic field fails to increase, so that the current developed remains small.

Now, if, as in the case of the electric locomotive, the external circuit consists of a second machine to be worked as a motor, the resistance of which is very small, the generator will not develop current enough to start the motor. If, however, the leading wires add sufficient resistance to the external circuit to cause the diversion of an appreciable current into the derived or field-magnet circuit of the generator, its magnetic field will increase in power and the current induced in the armature will consequently be greater in volume, and perhaps enough to start the motor. Consequently, it would appear expedient to increase the external resistance at the time of starting the generator, so that its magnetic field may be charged sufficiently. When the motor begins to move it develops a counter electromotive force in the circuit which practically amounts to so much electrical resistance and causes the further diversion of current into the magnetic field circuit. Thus, when once started, the counter electromotive force of the motor answered the purpose of resistance. It was found practically by Messrs. Rae and Healy in preliminary experiments with these two machines that the condition of best efficiency of the generator was realised when the motor had attained its maximum speed, and that the power developed was greater at that time. From this they inferred that the proper moment to put the load on the motor was when it had reached its greatest velocity.

The mechanism by means of which this was accomplished is seen in fig. 5, which represents a rear end elevation of the locomotive without the cab. The loose pulleys, G, G, run on the axle of the drivers, W, W, as previously stated, motion being transmitted to them by belts from the pulleys of the countershaft, as already shown in figs. 3 and 4. F, F, F′, F′ are cone friction pulleys fitting into the interior of the rim of the loose pulleys. These friction pulleys revolve with the shaft, being connected thereto by means of keys and keyways, which are loose, however, so that the friction pulleys can be free to slip lengthwise on the axle as

they revolve. The hub of each friction wheel, F_1, F_1, carries a collar, E, E, which is connected by arms, D, D, to a lever, B, fulcrumed at C on a projection from another collar fitted around the shaft. The operation of this form of friction clutch will be readily understood. In the position shown the friction cones, F, F, F_1, F_1, are removed from the pulleys, which are free to move loosely upon the axle. But upon moving the lever, B, to the right the friction cones are both moved outward from the centre, and caused to engage the inner surface of the pulleys, and thus the motion of the loose pulleys is communicated to the drivers, W, W.

As already stated, the central rail of the track formed one conductor and the two outside rails, R, R, the other. The device for "picking up" the current was quite ingenious, and is also shown in fig. 5. It consists of a kind of inverted vise firmly bolted to an arm, H, H, projecting downward from the frame of the locomotive. The jaws, N, N, of the vise are each perforated with three holes directed obliquely downward and inward, through which bundles of phospor-bronze wire pass, being securely fastened and held by a screw, O. A spring, S, extending between the arms of the vise serves to bring the two brushes M, M, into close and sure electrical contact with the central rail, P. The wire being stiff and firm, the contact is equally certain whether the locomotive is moving forward or backward.

An important feature of this electric locomotive is the means by which the speed may be regulated at pleasure.

There is a "throttle-valve" arrangement resembling that found in every American locomotive, and which answers the same function, namely, to control the amount of force put in action. This device consists simply in a lever (fig. 6), by the motion of which the resistance of a suitable rheostat may be thrown in and out of the main circuit, thus controlling the amount of current flowing therein. The lever is placed horizontally and can move over contact segments disposed in a circle. These segments are insulated from each other, but they are connected by coils of iron wires so as to make a certain resistance, and possessing sufficient sectional area to remain cool. Thus, when the lever is in the position shown in the figures, there is no resistance included in the circuit. When the lever is moved forward to the next segment, the resistance added to the circuit is 0·1 ohm. On moving to the next the resistance added is 0·2 ohm, and so on, the amount of resistance included in circuit when the lever touches each segment being in fig. 6 indicated by the figures thereon. The rheostat comprised two Edison B lamps of 85 ohms each, so that the total resistance when the lever touched the last segment was 174 ohms.

The high resistance necessary at starting to cause the magnetic field of the generator to magnetise itself was readily afforded by this rheostat on closing the circuit. Another interesting feature of the Chicago electric locomotive is the device by means of which the current is reversed at the motor when it is desired to make the locomotive move backward (fig. 7). The lever, J, causes the wheel, H, H, to turn on the armature shaft, G. This wheel gears with two wheels, E, F, to which are fastened arms, C, C. D, D. These arms carry brush-holders and brushes, A_1, A_2, B_1, B_2. The function of the device is simply to change the relative direction of the current through the armature of the motor. In the position shown in the figure the positive brush, B_2, touches the commutator at the left-hand side, while the negative brush, A_2, touches it at the right-hand side. On moving the lever, J, as far as R, the brushes, A_2, B_2, leave contact. On moving the lever still further the brushes, A, B, now come in contact with the commutator of the motor, so that the positive brush, B_1, touches the right-hand side of the commutator and the negative brush, A, the left-hand side, instead of the opposite. The result is necessarily a reversal of the direction of rotation of the armature of the motor.

In this condition the motor is out of the circuit and receives no current. This is just the same as when the reversing lever of a steam locomotive is moved halfway, thus cutting off the steam entirely by preventing the motion of the slide-valve.

The locomotive was also provided with an electric bell. This bell had a resistance of 350 ohms, and was rung by a switch, which placed it in parallel circuit with the motor. Its high resistance prevented the diversion of the current from the motor in any appreciable quantity.

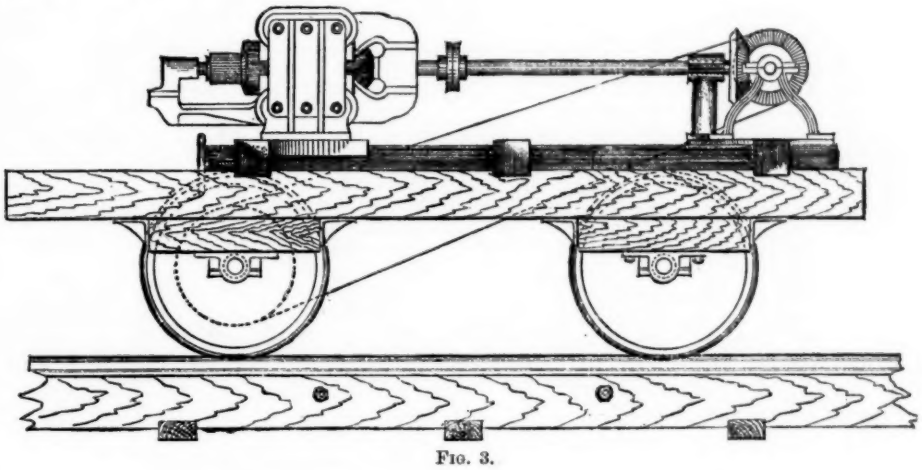


FIG. 3.

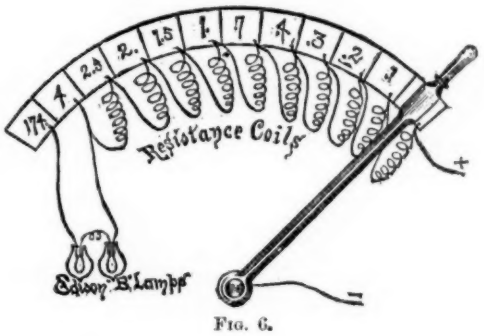


FIG. 6.

The locomotive was 12 feet long and 5 feet wide. Its total weight was about 3 tons. It was intended to be run with two passenger cars, but it was found upon inspection that the gallery was too weak to stand the strain. Even after having been strengthened it was not deemed expedient to exceed the speed of nine miles an hour. The work of construction was done by the Excelsior Iron Works of Chicago, and the promptness and accuracy which characterised it were very creditable to the establishment.

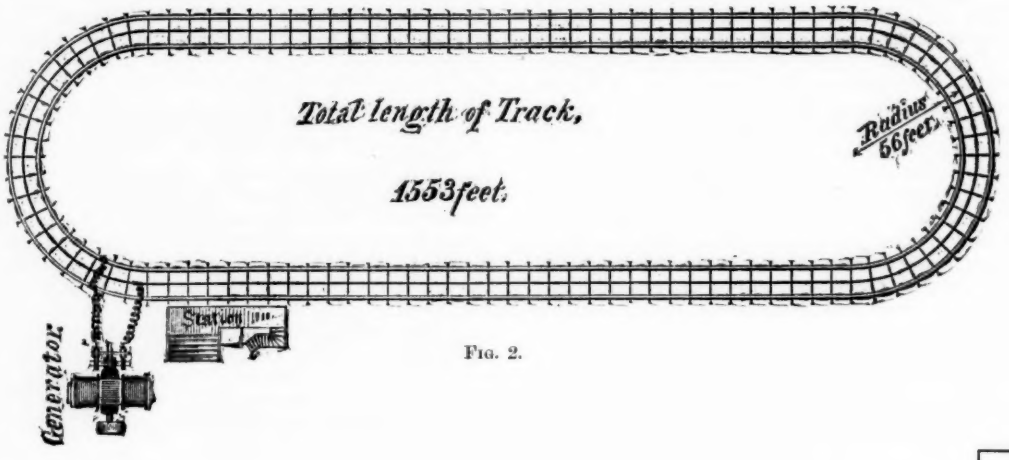


FIG. 2.

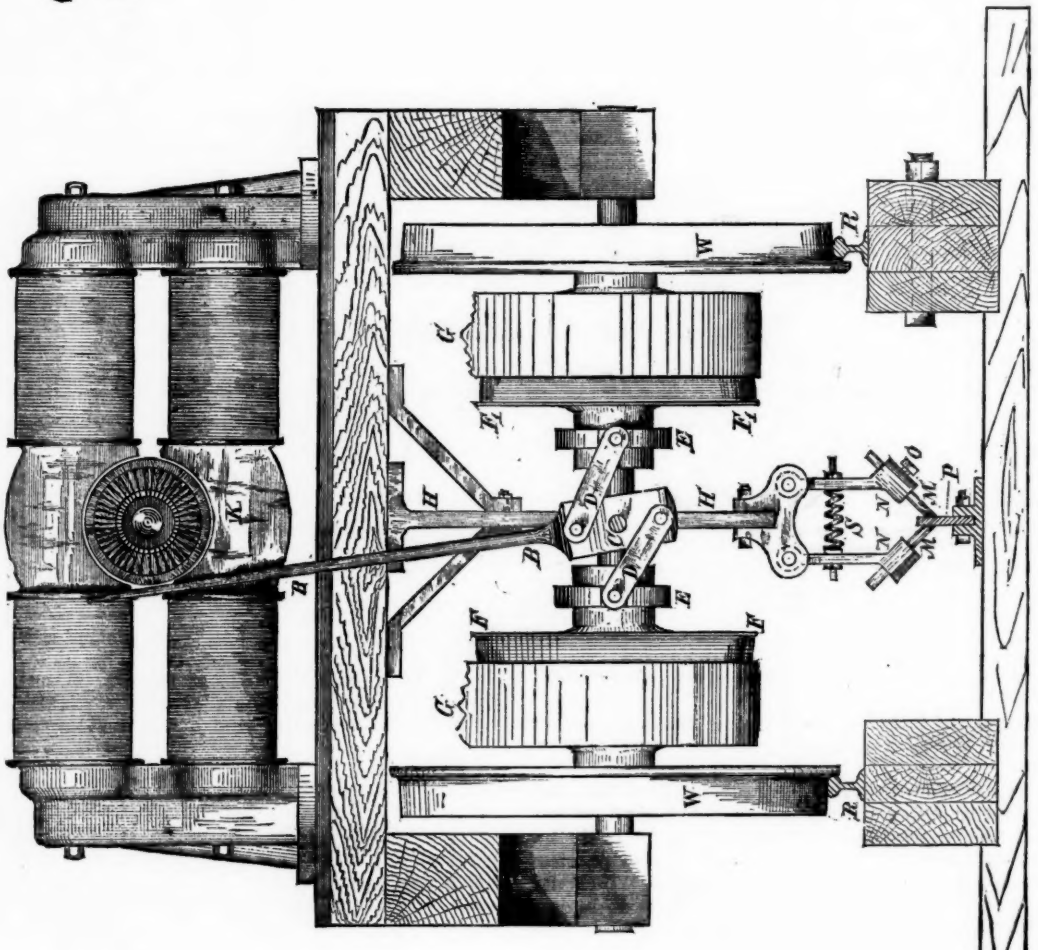


FIG. 5.

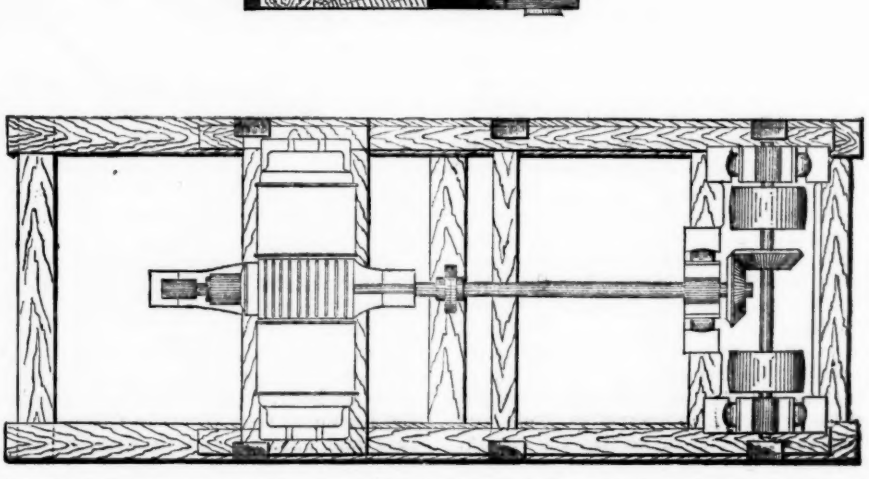


FIG. 4.

The Chicago electric railway was the first constructed in America for business purposes, and, considering the short lease of active life which was left to it after it was finally completed and put in operation its success is most surprising. Owing to delay in receipt of the report of the engineer entrusted with the task of strengthening the gallery, the road was not permitted to operate for business until June 9th, but experimental trips of the electrical locomotive were made daily from June 2nd.

On June 5th, "The Judge" and its attached car, loaded with 16 passengers (consisting of Commissioners of the

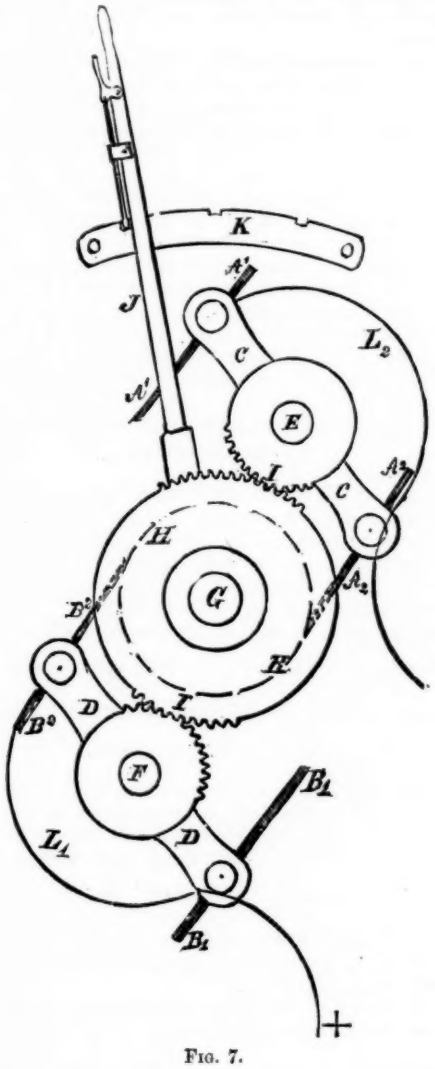


FIG. 7.

Exhibition and friends, all of whom were required to pay fare), was started by Mr. J. McGregor Adams, and moved around the track. The railway was opened for business on June 9th and closed June 23rd, having run in all 118¾ hours and 446.24 miles.

The daily report of trips made and passengers carried is as follows :—

	Trips.	Passengers.
Saturday, June 9	72	1,553
Monday, „ 11	60	985
Tuesday, „ 12	88	1,316
Wednesday, „ 13	99	1,552
Thursday, „ 14	109	1,372
Friday, „ 15	108	1,567
Saturday, „ 16	158	2,873
Monday, „ 18	115	1,654
Tuesday, „ 19	117	2,154
Wednesday, „ 20	148	2,484
Thursday, „ 21	142	2,829
Friday, „ 22	172	2,886
Saturday, „ 23	194	3,580
Totals	1,588	26,805

The success of the enterprise is due largely to the patronising efforts of Mr. J. McGregor Adams, one of the commissioners, who placed every facility at the disposal of the Electric Railway Company, and rendered every assistance in completing the arrangements.

"The Judge" has been sent to Louisville, where an electric railway is being completed, to be in operation during the continuance of the exhibition just opened at that place. Mr. Adams is also interested in this new venture, and Mr. Frank B. Rae will be the electrician in charge, as at Chicago.

The uninterrupted operation of the electric railway during the last two weeks of the exposition precluded the possibility of making any measurements from which a definite idea of efficiency or of the cost of maintenance could be formed.

[We have to express our thanks to the *Electrical World* of New York for the information here given, and the blocks for the necessary illustrations.—EDS. ELEC. REV.]

ELECTRO-MOTORS AND THEIR GOVERNMENT.

By Professors W. E. AYRTON, F.R.S., and JOHN PERRY, M.E.

(*Continued from p.* 119.)

We will next consider the case

2nd. *When constant current is maintained through the motors.*

In fig. 11 let a and f be the resistances of the armature and field-magnet respectively, A and F the currents passing through the armature and field-magnet, and C the total current which by the supply conditions is kept constant; then, if e is the back electromotive force produced when the motor is running at n revolutions per minute,

$$e = n\ (p + q\,\mathrm{F} - \mathrm{K\,C}),$$

where p is a constant depending on the permanent magnetism in the field-magnet, q on the winding of the shunt coil, and K on the winding of the demagnetising coil on the field-magnet.

But $$e = f\,\mathrm{F} - a\,\mathrm{A},$$

∴ the total work the motor can do in consequence of its motion equals

$$\begin{aligned} e\,\mathrm{A} &= \mathrm{A}\,n\,(p + q\,\mathrm{F} - \mathrm{K\,C}), \\ &= \mathrm{A}\,(f\,\mathrm{F} - a\,\mathrm{A}). \end{aligned}$$

But $$\mathrm{F} + \mathrm{A} = \mathrm{C},$$

therefore, eliminating F, we have the total work equal to

$$\mathrm{A}\,n\{p + q\,(\mathrm{C} - \mathrm{A}) - \mathrm{K\,C}\} = \mathrm{A}\{f\,(\mathrm{C} - \mathrm{A}) - a\,\mathrm{A}\},$$

which we desire to be able to vary at will without varying n. Hence, as this equation must be true for all values of A, we must have the coefficients of A equal, as well as those of A^2, so that

$$\begin{aligned} f\,\mathrm{C} &= n\,\{p + (q - \mathrm{K})\,\mathrm{C}\}, \\ f + a &= n\,q \end{aligned}$$

are the conditions for governing when constant current is supplied to the motors. And the second of these means that the normal speed of the motor must be the critical speed for the motor when used as a shunt dynamo with an infinite resistance external to the machine.

If the shunt coil be a shunt to both the armature and the demagnetising coil, as shown in figs. 12 and 13, then the equations become

$$\begin{aligned} e &= n\,(p + q\,\mathrm{F} - \mathrm{K\,A}) \\ &= f\,\mathrm{F} - (a + r)\,\mathrm{A}. \end{aligned}$$

where r is the resistance of the demagnetising coil. Now, the first equation may be put into the form

$$e = n\{p + (q + \mathrm{K})\ \mathrm{F} - \mathrm{K\ C}\},$$

therefore these equations are exactly like the two employed in the previous case, except that $q + \mathrm{K}$ replaces q, and $a + r$ replaces a. Consequently, if these

changes be made in the former equations for governing, we shall have the equations for governing applicable to this second case, which are, therefore,

$$f\,\mathrm{C} = n\,(p + q\,\mathrm{C})$$
$$f + a + r = n\,(q + \mathrm{K}).$$

And this second equation means that the speed at which it is desired the motor shall always run, independently of whatever work it may be doing, is the critical speed for the motor when used as a shunt dynamo when the resistance external to the motor is infinite.

In both these cases, therefore, for constant current, n the normal speed of the motor is the speed at which the motor will begin to feed itself when used as a shunt dynamo, the external circuit being broken, but the connections in the motor itself left untouched.

In working out this theory we have, for simplicity, assumed—what is generally true in dynamos—that the magnetic field is mainly due to the action of the field-magnet. We will presently show why this is not the case in our motor, and why we believe it should not be the case in any good motor. But, although the difference in construction is very considerable, the formula employed in the mathematical investigation of the conditions for governing are similar to those we have employed, and consequently we have not thought it desirable to lengthen our paper by inserting them.

In the preceding we have also, for simplicity of calculation, assumed that the strength of the magnetic field produced by an electro-magnet is proportioned to the current passing round it, but this is, of course, only true when the magnet is far from saturation. A function, to express more accurately the strength of the field, must of course be such that for all very strong currents the field has a constant strength. Five years ago, Mr. Schwendler deduced, from his experiments on dynamo machines made at the India Store Department, that the equation connecting the electromotive force of a series dynamo, running at a particular speed, with the internal and external resistances was of the form

$$\mathrm{E} = \mathrm{K}\left\{1 - \mathrm{E}^{-a\left(\frac{r}{r'}\right)^2}\right\}$$

where r is the resistance of the machine, r' the external resistance in circuit, and K and a constants. And one of us who had the good fortune to be assisting Mr. Schwendler in these investigations, in 1878, made at the time a large number of calculations to determine the most probable value of the constants in this function. Having, however, previously (when engaged with our students in Japan in putting into a convenient form for calculation some of the results given in Wiedemann's "Galvanismus," for the strength of an electro-magnet) employed the expression $\frac{k\,\mathrm{C}}{1 + s\,\mathrm{C}}$ for the strength of the magnetic field produced by a current, C, flowing round an electro-magnet, we saw that the equation for the curve connecting the electromotive force of a dynamo with the current flowing through its coils could be expressed in the form

$$\mathrm{E} = n\left(p + \frac{k\,\mathrm{C}}{1 + s\,\mathrm{C}}\right),$$

where n is the speed, and p a constant depending on the permanent magnetism in the field-magnets; and this formula, which it would naturally strike any practical mathematician to employ, we used then, and have ever since used in our calculations on dynamo machines and motors, and in our lectures to students. From this equation we were led theoretically, at the commencement of 1879, to the idea of critical speed in a dynamo; but finding shortly afterwards that the idea of a critical speed had been foreseen some years previously by Sir William Thomson, and that it was already referred to in the reprint of his papers on electricity and magnetism, we did not think it necessary to refer publicly to the results we had arrived at by the use of the above equation. We, however, now take this opportunity of alluding to the use of this equation for expressing the total electromotive force for a dynamo in terms of the current flowing through its coils, since in France, Germany, and England this equation has comparatively recently given rise to various claims as to priority of employment.

Another formula which we have also for some years been in the habit of using to express the strength of an electro-magnet in terms of the current flowing through its coils is,

$$a \tan.^{-1} b\,\mathrm{C},$$

but this does not lend itself so readily as the preceding to algebraical manipulation or the theory of dynamo machines.

In the preceding investigation for governing motors we have, for simplicity, assumed that the resistance of the armature was a constant for a given temperature, but in reality this resistance depends on the number of reversals of magnetism in the coils of the armature per minute—that is, depends on the speed of rotation of the motor. That the resistance of the armature was not a constant was shown by M. Cabenallas in 1880,* but we are not aware that much attention has been paid to this very important fact in theoretical investigations of dynamo machines or motors, or that any attempt has been made to ascertain exactly how this increase of resistance depends on the speed of rotation and on the coefficient of self-induction. The calculation is comparatively simple, and is as follows :—

Increase of Resistance of the Armature due to Self-induction.

Let M′, fig. 14, represent, symbolically, a coil just on the point of being short-circuited by the brush A. On the armature moving in the direction of the upper arrow, as is the case in an ordinary dynamo or motor, or on the brush moving in the direction of the lower arrow, the armature being fixed, as is the case in our motor, the coil, M, which previously had no current flowing in it, will now have a current, $\frac{\mathrm{C}}{2}$, started in it, whereas the coil M′, which just previously had a current $\frac{\mathrm{C}}{2}$, flowing in it, will be short-circuited. The result of this will be that, even if the brush be exactly in a neutral part of the field, so that there is no electromotive force in a short-circuited coil due to its cutting lines of force, still a certain amount of energy will be expended in starting the current $\frac{\mathrm{C}}{2}$ in the coil, M, and an exactly equal amount of energy will be wasted in the coil, M′, by the strong current momentarily induced in it on short-circuiting.

If l is the co-efficient of self-induction of the coil M, then the back electromotive force in it, due to starting the current $\frac{\mathrm{C}}{2}$ in it, will be $\frac{1}{2}\,l\,\frac{d\,\mathrm{C}}{d\,t}$, and the amount of energy thus expended, to be wasted when this coil is short-circuited at the next brush, is $\frac{1}{2}\,l\left(\frac{\mathrm{C}}{2}\right)^2$ or $\frac{1}{8}\,l\,\mathrm{C}^2$. Hence, the waste of energy due to one coil passing a brush, however many coils there may be short-circuited at a brush at any one time, is $\frac{1}{8}\,l\,\mathrm{C}^2$, if the brush be in the neutral part of the field; or, if it be remembered that on a coil passing one brush, another coil symmetrically on the opposite side of the armature passes the other brush, the total loss of energy produced by the coil rotating through a circumferential distance equal to the breadth of one coil is $\frac{1}{4}\,l\,\mathrm{C}^2$. Hence, if L is the co-efficient of self-induction per radian of the

* *Comptes Rendus*, Tome 90, No. 23, June 7th, 1880.

coil, and if n is the number of revolutions per minute, the loss of energy per second is

$$\frac{1}{4} \text{L C}^2 \times \frac{2 \pi n}{60},$$

since $\frac{2 \pi n}{60}$ is the angle turned through per second.

The waste of energy per second is consequently $\frac{\pi n \text{ L C}^2}{120}$, and this corresponds with an increase in the resistance of the armature equal to $\frac{\pi n \text{ L}}{120}$ ohms.*

The following gives a sample of the results our students have obtained when actually measuring the resistance of a fine wire Gramme ring rotating at different speeds in space at a distance from any iron except the iron wire composing its core, and traversed by a current which was kept constant in strength to avoid any change in the static resistance arising from changes in the heating of the wire by the passage of the current :—

Number of revolutions per minute.	Current in ampères traversing the Gramme ring.	Approximate. Resistance in ohms.	Increase of resistance.	Equivalent back E.M.F. in volts.
0	·00488	1,768	...	...
670	,,	1,800	32	·156
825½	,,	1,810	42	·209
1,050	,,	1,900	132	·642
1,300	,,	1,920	152	·744
1,490	,,	1,995	227	1·15
1,770	,,	2,060	292	1·42
2,230	,,	2,200	432	2·12

A number of sets of experiments similar to the above were made, and all led to the same result—that the resistance increases more rapidly than the speed, instead of the increase being proportional to the speed, as might have been expected from our reasoning on self-induction just given. Since the reading the paper, however, the main cause of this apparent discrepancy between theory and practice has been discovered, and is as follows :—In order to eliminate the effect of the earth's magnetism setting up an electromotive force in the rotating bobbin, the brushes were so placed on the commutator that when the bobbin was rotated at a particular speed no electromotive force was set up due to the earth. But in reality such an adjustment of the brushes must be made for every speed, unless the axis of rotation of the bobbin is that of the dip, since the magnetic poles induced in the iron of the bobbin are carried forward by the rotation, and are carried forward the more the greater the speed. In spite, therefore, of the careful adjustment of the brushes in obtaining the results, a sample of which is given above, it was only at one particular speed that there was no electromotive force due to the earth : at all speeds below this the electromotive force was assisting the current used for testing, and at all speeds above this it was opposing this current, thus making the increase of resistance too small at low speeds, and too large at the high.

To eliminate the error produced by the shifting of the poles by rotation, without resorting to the very troublesome operation of adjusting the brushes for each speed, we have in all our later experiments taken readings with both a positive and a negative current at each speed, and the following is a sample of the more accurate results thus obtained, the resistance of the Gramme ring at rest being 1,860 ohms :—

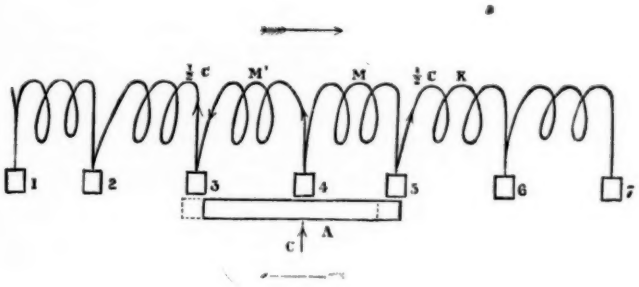


FIG. 14.

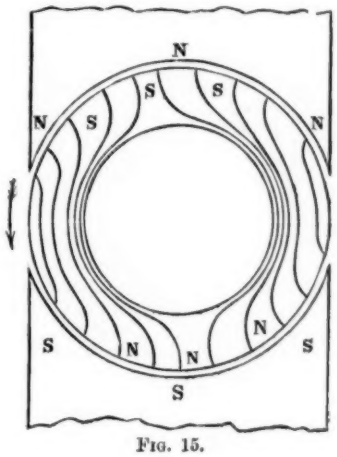


FIG. 15.

Revolutions per minute.	Increase of resistance. + Current.	Increase of resistance. − Current.	Mean increase of resistance.	Increase of resistance calculated from $\frac{\pi n \text{ L}}{120}$
600	70	50	60	75
800½	110	75	92	100
1,000½	150	90	120	125
1,205	200	110	155	150
1,400	245	130	187	175
1,602	320	120	220	200
1,806	405	150	277	212
2,000	480	190	335	250

Here the increase of resistance is far more nearly proportional to the speed than before, and what is still more interesting, is approximately what is obtained by using the formula $\frac{\pi n \text{ L}}{120}$, given above, up to speeds of about 1,600 revolutions per minute. For experiments made to determine the coefficient of self-induction by the Wheatstone's bridge method, described by Clerk Maxwell, showed that it was about 7·5 ohms. The last column above shows the increase of resistance calculated from the expression $\frac{\pi n \text{ L}}{120}$, using this value for L.

In addition to this increase of resistance due to self-induction, there is, as is explained further on, a back electromotive force set up by the magnetic poles formed in the gramme ring by the testing current not being at the brushes themselves, but, instead, carried forward by the rotation ; and it is possible that this electromotive force, not being proportional to the

* Since presenting this paper we have learnt that a somewhat similar calculation has been recently made by M. Joubert, and his calculation will be found in the *Comptes Rendus*, Tome 96, No. 10, for March 5th of this year ; but M. Joubert's result is not expressed in the simple form of an increased resistance of the armature as we have here expressed it.

speed, is the reason why the total increase in the resistance is not strictly proportional to speed, or it may be that at the very high speeds there is a slight jumping of the brushes. The real cause we are now endeavouring to ascertain experimentally.

In the preceding we have spoken of the armature as moving in ordinary motors, and the armature as fixed in ours. To make this quite clear, we may mention that we define the "armature," whether movable or fixed, of a continuous current dynamo or motor as that part of the machine in which the current is being perpetually reversed as the machine works; and the "field-magnet," whether fixed or movable, as that part round which the current is always flowing in the same direction.

Resultant Magnetic Field, and the Proper Lead to give to the Brushes In a Dynamo and in a Motor.

In an actual dynamo machine or motor, in addition to this practical increase in the resistance arising from self-induction, the power of the machine will be affected—

1st. By the magnetic field due to the field-magnet being rotated, and therefore weakened by the rotation of the armature.

2nd. By the magnetic field due to the current in the armature being added to that due to the field-magnet.

3rd. By an actual back electromotive force set up in the armature of a dynamo, for the reasons to be explained further on.

It has usually been assumed that the magnetic field produced by the current flowing round the armature must, both in a dynamo and in a motor, weaken the one set up by the field-magnet. It has further been assumed that since a forward lead is given to the brushes in a dynamo on account of the delay in the magnetisation, that therefore a backward lead ought to be given to the brushes in a motor, to give time for the current to magnetise the iron of the armature. And lastly, it has been taken for granted that because, in both a dynamo and in a motor, the motion of the armature and field-magnet relatively to one another produces an electromotive force, therefore, since experience had shown that a powerful field-magnet and an armature of a comparatively weak magnetic moment were the best for producing a large electromotive force in a dynamo, the same proportion of field-magnet and armature must be the best to produce a powerful motor. As these three assumptions appeared to us unproved, we have thought it desirable to investigate what ought to be the relative strength of the magnetic fields produced by the field-magnet and by the armature in a motor.

In considering the strength of the field produced between field-magnet and armature by the field-magnet and armature currents respectively, if F and A are certain functions of the currents and number of windings in the field-magnet and armature respectively, then F+A represents the total number of lines of force in the field, or what we may call the total strength of the field when the brushes have 90° of lead and the armature and field-magnet are at rest. With any other lead, F will remain the same, but A will be reduced. Both F and A may be expressed in the form $\frac{k\,C}{1+s\,C}$.

If the armature and field-magnets are rotating relatively to one another, then the field due to the field-magnet will be twisted round, and consequently weakened.

Fig. 15 shows approximately, in the case of a Gramme machine, the distribution of the lines of force due to the field-magnet as twisted round by the rotation of the armature.

If, now, θ is the angular distance from the position of a brush when there is no lead, then the number of lines of force passing through a coil of the armature at any place due to the field-magnet alone is proportional to

$$f(n)\ \mathrm{F}\cos.\ (\theta-\gamma),$$

where γ is a function of n, the number of revolutions per minute. It seems, from the results of such experiments as have hitherto been made, that $f(n)$ and $-\gamma$ are nearly constant for small values of n, and diminish the more rapidly as n becomes considerable. The shapes of these functions vary with the shape of the armature and the nature of the iron. It is of course obvious that, instead of the simple periodic function cos. $(\theta-\gamma)$, we ought to employ a Fourier's series to express the condition of a particular machine, a very important term in this series having a periodicity defined by the number of coils on the armature if any iron protrudes between the coils. But for general purposes the simple form is sufficiently correct. Now, if the brushes have a lead, ϕ, in the direction of motion, it is obvious that the electromotive force due to rotation will be proportional to

$$n\ \mathrm{W}'\ f(n)\ \mathrm{F}\cos.\ (\phi-\gamma),$$

where W′ is the number of windings on the armature, since, as the distribution of lines of force at each brush is symmetrical, the electromotive force due to rotation must be proportional to the number of lines of force cutting a ring at a brush—that is, must be proportional to the value of the last expression, when θ equals ϕ.

If the field produced by the current flowing round the armature were symmetrical, and not affected by the iron of the field-magnet, as it is often erroneously supposed to be, and if it were merely twisted round by rotation, as shown in fig. 16, then the number of lines of force passing through a coil of the armature at any place due to the current in the armature alone would be proportional to

$$+\ f(n)\ \mathrm{A}\sin.\ (\theta-\phi-\gamma);$$

and, as before, the electromotive force arising from the rotation of the coils in this field would be proportional to the value of this last expression, when θ equals ϕ, or to

$$-\ n\ \mathrm{W}'\ f(n)\ \mathrm{A}\sin.\ \gamma.$$

In the case of a dynamo machine, the resultant magnetic field is usually supposed to be due to the fields shown in fig. 15 and in fig. 16, for which latter case the sign of the last expression is, as stated, negative. In a motor, as we shall show further on, the field due to the armature may assist that due to the field-magnet, so that the distribution of lines of force due to the armature shown in fig. 16 may be adopted, but with the N and S interchanged, and in that case the number of lines of force passing through a coil of the armature at any place due to the current in the armature alone would be proportional to

$$-\ f(n)\ \mathrm{A}\sin.\ (\theta-\phi-\gamma),$$

and the electromotive force arising from the rotation of the coils in this field would be proportional to

$$+\ n\ \mathrm{W}'\ f(n)\ \mathrm{A}\sin.\ \gamma.$$

Hence, if the field due to the armature were a symmetrical field, the poles being at the brushes when the armature is at rest and only slightly shifted round by the rotation, as shown in figs. 15 and 16, then in a dynamo machine the electromotive force would be proportional to

$$n\ f(n)\ \mathrm{W}'\left\{\mathrm{F}\cos.\ (\phi-\gamma)-\mathrm{A}\sin.\ \gamma\right\},$$

and in a motor to

$$n\ f(n)\ \mathrm{W}'\left\{\mathrm{F}\cos.\ (\phi-\gamma)+\mathrm{A}\sin.\ \gamma\right\}.$$

In fig 17, B, B is the development of the centre line of the ring from brush to brush. The curve, F, shows by its ordinates the number of lines of force passing through the armature coils at every part of the ring, due to the field-magnet action only; the curve, A, shows the same thing in the case of the dynamo, and A′ in the case of the motor, for the armature magnetic action only. D shows the sum of F and A for a dynamo, and M the sum of F and A′ for a motor. The electromotive force in the case of a dynamo will be proportional to 2 B D, and in a motor to 2 B M.

We have already stated that we do not recognise the assumption usually made that the armature field must

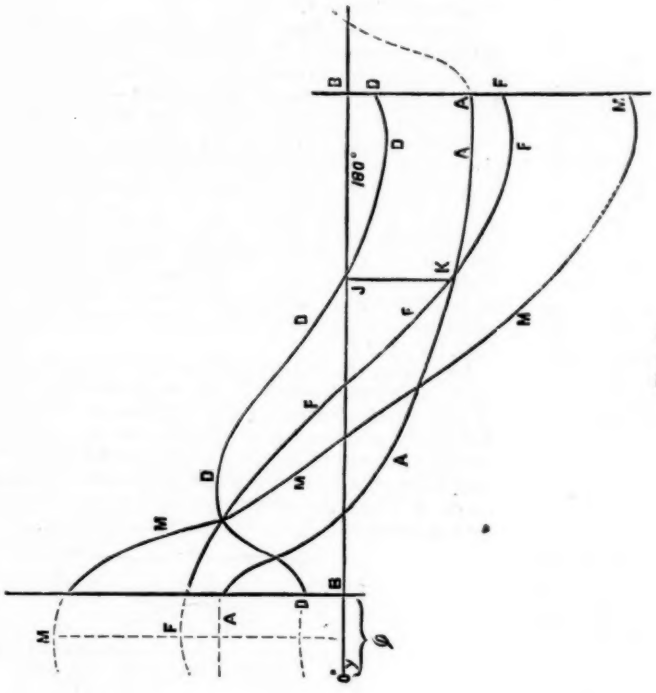


Fig. 18.

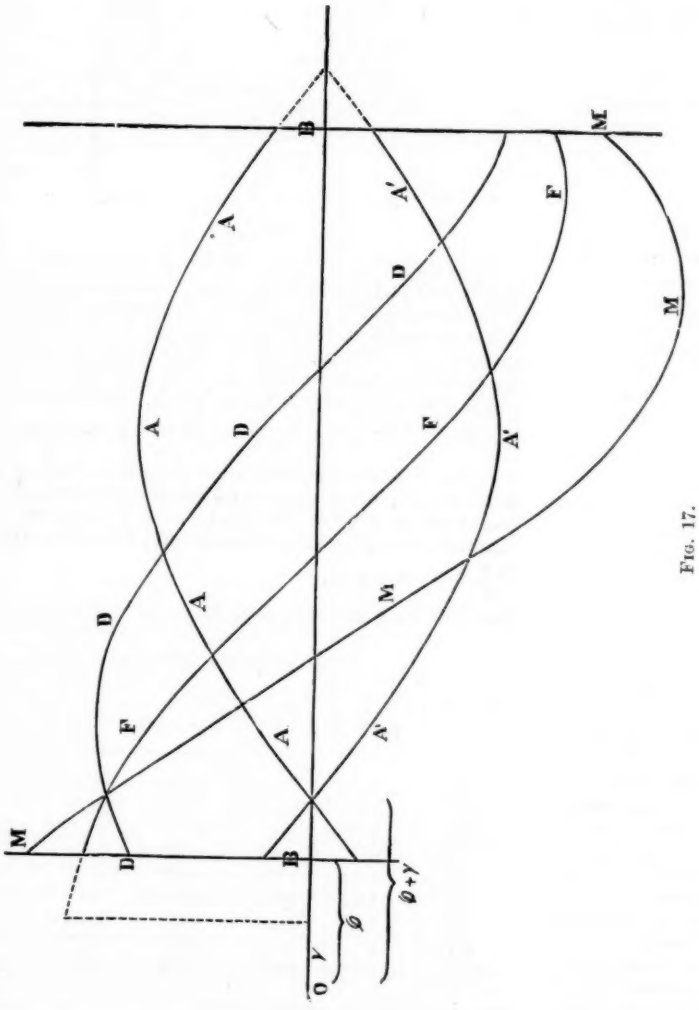


Fig. 17.

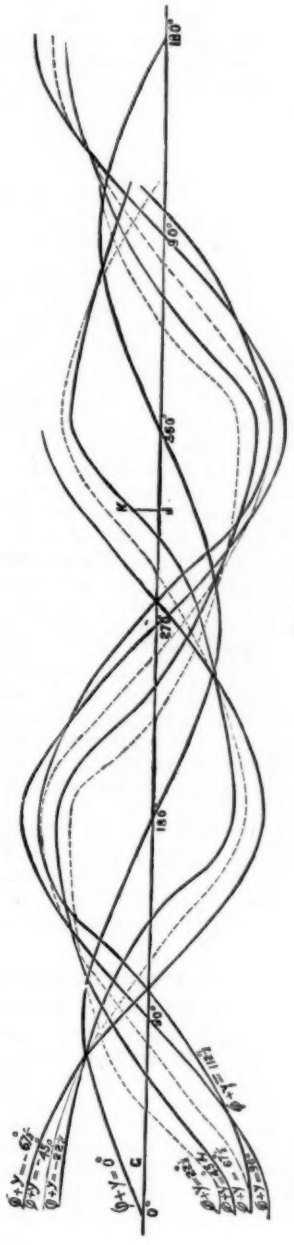


Fig. 19.

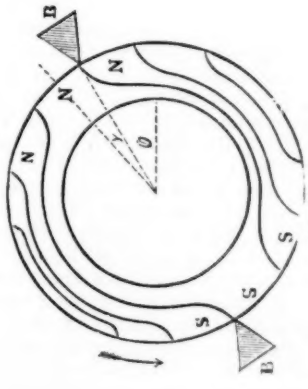


Fig. 16.

weaken the field-magnet field in a motor as it does in a dynamo; but if the lead of the brushes in a motor is sufficiently far back, then the armature field will no doubt weaken the field-magnet field, as in the case of a dynamo, and the negative sign above must be taken.

To illustrate this, here is one of our motors so arranged that the wires passing round the field-magnet can be short-circuited, in which case the magnetism in the field-magnet will only be that produced by the induction of the armature. The lead of the brushes is put back so that the armature field weakens the field-magnet field as in an ordinary dynamo. Now observe what happens. On starting the current the motor works as an ordinary motor, but on merely short-circuiting the field-magnet coils it stops, and rotates nearly as forcibly in the opposite direction. When the current then passed through the field-magnet there were strong negative forces opposing the motion, but which were overcome by the current passing through the field-magnet coils. The resultant action, therefore, was a difference, and consequently small. Now let us turn the brushes so as to give a more forward lead; the two actions help one another; the resultant is a sum, and the motor works more vigorously.

Although the adding together of the magnetic fields in motors is thus produced by a forward lead of the brushes, it may be possible in some cases that, owing to the iron of the armature being very hard, γ is so large that a backward lead of the brushes in a motor may produce an addition of the magnetic fields corresponding with a positive sign in the expression for the electromotive force. But under such circumstances $f(n)$ will be small, as rapid rotation will seriously diminish the magnetic moment produced by the current. In all cases, however, what has to be aimed at in a motor is the adding together of the magnetic fields produced by the field-magnet and by the armature.

We cannot lay too much stress on the importance of this fact—a motor must work mainly by attractive forces, and not by repulsive forces. The magnetic fields due to the field-magnet and armature must help one another, and not oppose one another, as in the case of a dynamo.

Distortion produced by the Iron of the Field-Magnets of the Field due to the Armature.

When an ordinary dynamo machine is used as a motor, the attractive forces due to induction of the armature on the poles of the field-magnet are small, but in these motors of ours they are large, since the magnetic moment due to the armature coiling is large; and we wish to show that in an efficient motor the attractive forces ought to be made large, whereas in a dynamo they ought to be small.

In fact, in making any calculations from the distribution of lines of force, we must remember that not only does the iron in the armature determine the distribution of the lines of force due to the field-magnet, but that the iron in the field-magnet affects the distribution of the lines of force due to the armature. Indeed, as shown in fig. 16A, corresponding with a motor with a forward lead, the field due to the armature is by no means the same in the four quarters of the ring. The polar extensions of the field-magnet cause the intense part of the field to be at N and S, instead of at the brushes, B, B; and not only is the field twisted round, but we have on one side of N or of S in the armature a more sudden diminution of the field strength than on the other side. In fact, instead of the curve of cosines, we have the curve shown in A, fig. 18. Combining this with the field-magnet distribution given already, and represented in F, fig. 18, we have the sum of these shown at M as the distribution for a motor, and the difference shown at D for a dynamo machine.

The electromotive force in a dynamo is therefore proportional to 2 B D, and in a motor to 2 B M.

Generalising roughly, for all shapes of machines it may be said that, whilst the electromotive force due to the rotation remains what it was before for the field-magnet distribution—viz., $n\,W'\,f(n)\cos.(\phi-\gamma)$, it assumes a different form for the armature from that previously obtained.

In the previous case, when the action of the iron of the field magnets on the armature field was neglected, it was easy to express the equation for the curve, A, A, A, fig. 17, in terms of θ, ϕ, and γ, and from this, by making θ equal to ϕ, to find the expression for the electromotive force due to the armature field. But in the second case, when the disturbing action of the soft iron of the field-magnets is taken into account, we cannot from the one curve, A, A, A, fig. 18, express its equation in terms of θ, ϕ, and γ, seeing that the one curve alone gives no indication of how its form varies with changes in ϕ and γ. We have therefore in fig. 19 drawn the curve, A, A, A, for various values of $\phi+\gamma$, equal respectively to $-67\frac{1}{2}°$, $-45°$, $-22\frac{1}{2}°$, $0°$, $22\frac{1}{2}°$, $45°$, $67\frac{1}{2}°$, $90°$, $112\frac{1}{2}°$.

As before, the horizontal line represents the development of the centre line of the ring, and the ordinates of any particular curve the number of lines of force due to the armature field as affected by rotation, and by the presence of the iron of the field-magnets which pass through a coil on the armature at any angular distance, θ, from the origin for that value of $\phi+\gamma$ for which the particular curve has been selected.

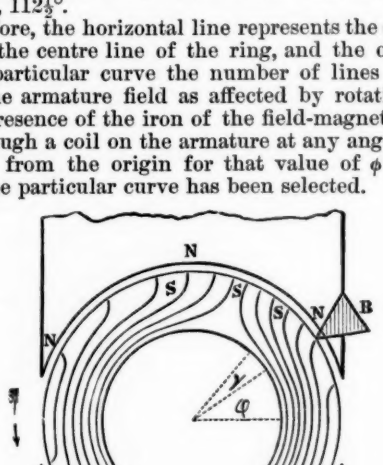


FIG. 16A.

From these curves in fig. 19, by giving to γ the values $0°$, $22\frac{1}{2}°$, $45°$, $67\frac{1}{2}°$, and $90°$, we have calculated numbers proportional to the respective electromotive forces due to the rotated and distorted armature field divided by the speed of rotation. This we have done by measuring the ordinate which in each case for each curve corresponds with the position of the brush. For instance, to find the $\frac{\text{E.M.F.}}{n}$ when $\phi+\gamma$ equals $45°$ and γ equals $22\frac{1}{2}°$, we must first select the curve corresponding with $\phi+\gamma$, equal to $45°$; next we see that the brush which has the lead ϕ or $(\phi+\gamma)-\gamma$ is really at $22\frac{1}{2}°$ from the zero. Hence G, H is proportional to the left of the figure to the $\frac{\text{E.M.F.}}{n}$ in this case.

The following table gives all the results so obtained:—

$\phi-\gamma$.	E.M.F. ÷ n for the following values of γ.				
	$\gamma=0$.	$\gamma=22\frac{1}{2}°$.	$\gamma=45°$.	$\gamma=67\frac{1}{2}°$.	$\gamma=90°$.
$-67\frac{1}{2}°$	$-0{\cdot}62$	0·67	1·87	2·75	3·33
-45	$-1{\cdot}00$	0·12	1·12	1·92	2·46
$-22\frac{1}{2}$	$-1{\cdot}79$	0·12	0·87	1·57	2·00
0	0	0·72	1·33	1·83	2·00
$22\frac{1}{2}$	1·75	2·50	2·47	2·33	2·00
45	1·01	2·42	3·00	2·83	2·75
$67\frac{1}{2}$	0·58	1·88	3·04	3·50	3·29
90	0	1·46	2·75	3·62	4·00
$112\frac{1}{2}$	$-0{\cdot}77$	0·67	1·83	2·67	3·22

(*To be continued.*)

THE "HAMMER" TELEPHONE OF M. DE LOCHT-LABYE.

THIS telephone constitutes, it is claimed, quite a new and original arrangement for transmitting speech. It has been, up to the present, almost universally supposed that for the telephonic reproduction of speech, the employment of continuous undulatory currents is indispensable. Professor Bell is looked upon as the originator of this theory, and his great influence in the scientific world, and especially his invention of the telephone with stretched membrane or flexible disc as an application of this theory, supported him, and for the time silenced all contradiction.

It is claimed for the De Locht-Labye telephone that it has no flexible organ, no part susceptible of the undulatory movements, which are, as Bell said, the reproduction or fac-simile of the sound waves of the air.

We will explain, in a few words, the construction of the receiving apparatus, which we have shown in perspective and in side elevation in the accompanying sketch. A horse-shoe magnet, M, has at its poles two little cores of soft iron, on which are placed coils C, of insulated copper wire. This magnet is fixed immovably to a wooden frame, F, which serves as a support to the whole apparatus. In front of the poles of the magnet, and at a very little distance from them, although this distance can very easily be regulated, as we shall soon see, is an armature, consisting of a *thick inflexible* bar of iron. This bar forms part of a *fixed lever*, L, moving freely on a *fixed axle*, placed on a little rod of copper, brass, or any other material. As we see, by its position, the armature lever is thus apparently a *free reed*, and is, in itself, in no way of the nature of a flexible disc. It is only fixed to the support by its axle, and is not connected with any membrane or other organ. It is terminated by a little hammer of metal, or some other substance, fixed to the extremity of a regulating screw, S. This hammer, in its normal position, rests upon a thick, rigid, inflexible piece of wood, glass, ebonite, or any other material, D, of any shape whatever, but which, for the sake of symmetry, has been made cylindrical in the apparatus, and to which is fitted an ear-piece, E. We must observe that, as the inventor who is now in London, has shown us, the ear-piece may form the part which supports the hammer, which shows, he thinks, that in no way is it of the nature of a membrane or flexible disc. The position of the armature lever is determined by the magnetic attraction of the poles of the magnet, the effect of which is *counterbalanced* by the reaction of the fixed portion supporting the hammer which terminates the lever. By the help of the screw which carries this hammer, we can easily regulate the distance between the poles of the magnet and the armature, so as to obtain the maximum telephonic effect.

These are the essential characteristics of the De Locht-Labye telephone.

Bell, in his original specification (Morgan-Brown patent, June 9th, 1877) made the following statement :—

"In all previous systems of telegraphy, messages have been received either by means of chemical changes produced by the action of the electrical current, as in the various forms of automatic and autographical telegraphs, *or by means of the mechanical movement of a portion of the receiving instrument*, operating to produce a visible signal, as in needle telegraphs, *a mark upon paper, or other material, as in printing telegraphs, or a sound, as in the Morse system.*"

He immediately adds :—

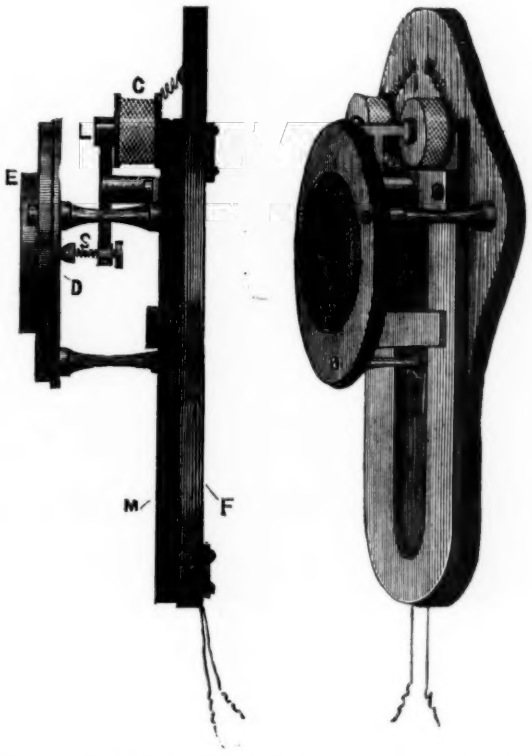
"Upon these and all other plans, *it has been found difficult, if not impossible*, to distinguish between more than four messages transmitted simultaneously over the same circuit, two in each direction"; and as Mr. Webster, Q.C., for the United Telephone Company (Limited), said, in his pleading :—

"*In no single case could it be pretended that Professor Bell intended his instrument to act as reeds.*" Now, in the De Locht-Labye telephone, it is claimed that the armature is a free reed. It is arranged in a manner that reminds one of the armature of the Morse telegraph, or, better still, of that of the Hughes printing telegraph, and, nevertheless, the transmission of sounds of all kinds and of speech is effected with complete success.

Numerous experiments have been made by experts with the instrument, of which we give a sketch, and it is declared unanimously that it works at least as well as the Bell telephone, as regards clearness and loudness of sound.

The inventor is convinced that he can make his instruments effect far more, and that, consequently, his results will considerably exceed those of the Bell telephone, so that his telephone can be employed for *very* long distances.

Thus, in order to show the essential points of difference between the De Locht-Labye and Bell telephones, from a mechanical point of view, one might say :—That the Bell telephone is characterised by the combination of a magnet, provided with a coil or coils at its pole or poles, *and a thin and flexible plate of iron or other inductive material fixed round its edge, over all the flat circumference near and at right angles to the magnetic pole;* whereas the De Locht-Labye telephone is



characterised by the combination of a magnet provided with coils at its poles, *with a rigid armature of soft iron or steel turning freely (as a free reed)* on an axle, and terminated by a *hammer* striking against a *rigid inflexible* body of wood, ebonite, or any other substance. De Locht-Labye's hammer telephone can work under the same conditions as Bell's flexible disc telephone—*i.e.*, it can be employed in the double function of transmitter and receiver.

It now remains for us to explain clearly the inventor' idea of the working of the telephone as a transmitter. Every sound wave, on reaching the rigid part, imparts to it a sudden shock, which it transmits instantaneously to the hammer. The latter then separates from the rigid part and gives rise to a slight movement, the extent of which is in proportion to the intensity of the shock—*i.e.*, to the intensity of the sound. But immediately the magnetic attraction acting continuously and with great force upon the armature, stops the movement of the armature lever, and restores it to its original position, so that the movable part can receive a fresh sound shock.

These sudden movements (of the lever) of the arma-

ture before the poles of the magnet engender in the coils covering the poles *instantaneous* electric currents, equal in number to the movements of the armature, and therefore to the sound shocks. These instantaneous currents, passing through the line, on reaching the end of it, are received by a similar apparatus.

The working of the telephone as receiver is then easily explained. The intermittent *instantaneous* currents, of exceedingly short duration, traversing the coils of the telephone, says the inventor, magnetise and de-magnetise at each emission. If the magnetising current is produced first, it is powerless to produce the movement of the armature lever, on account of the reaction of the inflexible body on which the hammer rests. The demagnetising current alone is capable of drawing back the armature, and consequently of detaching the hammer from the part on which it rests. This current being instantaneous, the movement is instantly arrested by the continuous action of the magnetic attraction, which restores the armature to its original position, and forces the hammer to strike against the block. It is this shock which produces *the sound* at the receiver. For each emission of the current there is one shock and only one. Its force is proportionate to the energy of the current, and therefore to that of the sound shock at the transmitting telephone.

All these movements are sudden, and can in no way possess a duration equal to that of a sound wave of air. The armature and the hammer are, therefore, nearly always in a position of rest, ready to receive new shocks and to transmit them to a distance.

The telephonic transmission of speech, then, according to M. De Locht-Labye, evidently results from a series of shocks, and he believes from the working of this apparatus that in order for speech and any kind of sound to be transmitted and reproduced, there must first be an equal number of sound shocks, little movements of the armature in the transmitter, and consequently of *intermittent* instantaneous currents of magnetisation and demagnetisation causing so many sudden movements of the armature at the receiver, and therefore so many blows of the hammer on the fixed part. There must be an exact interval of equal duration between two successive sound shocks, and finally the intensities of all these forces, the transformations of which reproduce the sound, must be in direct proportion to one another.

This is the conclusion to which M. De Locht-Labye's hammer telephone directly leads him.

We think that the description of this apparatus, and the explanations that we have given, may excite some interest, and M. de Locht-Labye has given us permission to state that he will be glad to receive, either through the medium of our journal or directly, any objections or requests for explanation that may suggest themselves, and that it will be both a duty and pleasure to him to answer them. We shall describe in a future number M. De Locht-Labye's "Pantelephone."

NOTES.

Electric Lighting. — Mr. H. C. Calcraft, of the Board of Trade, in a circular letter on the subject of electric lighting, dated the 17th inst., says :— Some of the applications to the Board of Trade are made by electric lighting companies, and extend over large areas, involving a large expenditure of time and money. According to the terms of the Electric Lighting Act, such licences can only be granted for seven years, and at the end of that time the undertakers and all the capital they may have expended are subject to the decision of the local authority and the Board of Trade as to whether the licence should be renewed, and if so, on what terms and conditions. It must be some time from the date of the licence, probably two or three years, before such an undertaking can be brought into full operation, and there would then remain not more than four or five years during which the undertakers could expect to reap the fruits of their enterprise. During this period, moreover, they would be exposed to severe competition with gas. It is difficult to believe that under such circumstances prudent and capable investors will be found able and willing to provide the capital necessary for so large and so hazardous an undertaking ; and that which is unsafe and imprudent for investors can seldom be for the ultimate good of the public. But this is not all. The grant of a licence when approved by a local authority and adopted by the Board of Trade is final, and there is not, as in the case of a Provisional Order, any means of preventing or modifying it by an appeal to Parliament. If, therefore, as has lately been the case in more than one instance, consumers should be dissatisfied with the action of the local authority and of the Board of Trade, they will, in the case of a licence, have no remedy. Under these circumstances the Board of Trade have come to the conclusion that they will grant no licences to electric lighting companies for wide areas, such as the whole of a provincial town or of a London parish. This does not apply to smaller areas, containing, for instance, a limited number of streets, squares, or public buildings, which a company may well be willing to light by way of experiment or otherwise. Nor does it apply to cases in which local authorities themselves are the applicants for the licence. I am to add that the Board of Trade, whilst adopting the above conclusion, and making it known for the convenience of applicants, do not propose to proceed with any of the licences now before them until October.

Mr. Francis R. Reeves, the general manager of the Jablochkoff Electric Light and Power Company, Limited, in a long letter in reply to the above, writes : —I venture to say that those who have followed the action of the Board of Trade with reference to this subject will consider that the Jablochkoff Company, at least, has been most unfairly treated by them. There is nothing in the Act to justify the assumption that the Board would discountenance licences ; on the contrary, this mode of procedure was put forward as the preferential one. Mr. Farrar, in his evidence before the Select Committee last year, said that the intention of the board was to encourage local authorities in every way, and Messrs. G. S. Bower and Walter Webb, in their excellent commentary upon the Electric Lighting Act, state that "a company having once obtained the consent of the local authority has nothing more to fear in its application for a licence," thus clearly indicating what was their intention at the time, viz., that the function of the Board of Trade in respect of licences was not to give nor withhold their consent at pleasure, but simply to supervise the details for the protection of the public. Had the authorities at Whitehall announced their decision as to licences before the 1st of July, we and other applicants for such powers could have given notice for Provisional Orders for next Session ; but the decision, one cannot help feeling, has been purposely withheld until it was too late for the companies interested to take the necessary steps to put themselves right.

In the House of Lords, on Friday of last week, the reports of amendments to the Electric Lighting Provisional Orders (Nos. 1, 5, 6, 7 and 8) Bills were read and agreed to, and on Monday these Orders were read a third time and passed.

At the invitation of Mr. James Paxman, of the firm of Davey, Paxman & Co., the well-known engineers, Colchester, a number of scientific gentlemen connected with electric lighting, and the public Press, met at dinner on Wednesday evening, in the Royal Pavilion in the Fisheries Exhibition, South Kensington. Mr. E. Birkbeck, M.P., presided, and in proposing the health of Mr. Paxman he alluded to the public spirit shown and energy displayed by that gentleman in erecting the necessary engines now providing the power utilised by the various installations of electric lighting at the Exhibition, constituting, as it does, the largest display yet made in England. The works at Colchester were

kept running night and day, and the engines, representing over 1,000 H.P., fixed and in operation in less than 10 weeks, without any delay in the delivery of ordinary orders. After dinner an inspection took place of the engine-shed, one engine of 400 H.P. deserving special notice. This is fitted with automatic expansion gear, the exact amount of steam proportional to the work required being admitted to the cylinder, and the cut-off valve regulated by the governor. The engine has been purchased by the Government for South Kensington. The party then visited other installations of interest. A new feature in the electric exhibition consists of six Hochhausen lamps, with a total illuminating power of 50,000 candles, placed on a tall mast, 120 feet above the ground. The effect is extremely good, not only in lighting up the vacant spaces between the various buildings, but enhancing the general beauty, in the Horticultural Gardens the parterres and fountains having the appearance of being under the light of the full moon. The colours in the Chinese lanterns are certainly much improved by the contrast. The Fisherman's Hall deserves a word of mention; the Wright and Mackie incandescent lamps used there are fitted in opalescent shades, subduing their light to a pleasant degree, yet with sufficient power for reading the smallest print.

On Monday afternoon, from Messrs. Napier, Shanks, and Bell's shipbuilding yard, at Yoker, the *Clan Matheson*, sister ship to the *Clan MacIntosh*, recently launched by the same firm for Messrs. Cayzer, Irvine, and Company, was successfully launched. The *Clan Matheson* is to be electrically fitted up on the same extensive scale as the other vessels of the Clan line.

The Spanish National Submarine Telegraph Company.—The manufacture of this company's cables, at the Silvertown Telegraph Works, is progressing satisfactorily. We understand that the lengths necessary to connect Cadiz with the Canary Islands have been completed, and that some 400 miles are already shipped in the contractor's cable steamer, *Dacia*. As specified by the *Gaceta de Madrid*, the points to be connected are Cadiz with Tenerife, a distance of 700 nautical miles; Tenerife with Palma, 55 nautical miles; Tenerife with Gran Canaria, 46 nautical miles; and Gran Canaria with Lanzarote, 96 nautical miles. These cables will be laid in accordance with a contract entered into between the Spanish Government and the Spanish National Company. The Spanish Government has appointed Messrs. Juan Ravina and Antonio Agustin, Directores, Jefes-de-Centro, of the Spanish Telegraph Service, to superintend the making and laying of these cables. The Spanish National Company has a second contract with the French Government to connect Tenerife with Senegal, a distance of about 800 nautical miles. The manufacture of this cable has already commenced, the French Government being represented by M. Rambaud, Ingénieur des Télégraphes. The interests of the Spanish National Company are looked after by Captain J. E. Hunter, R.N., and Mr. F. Ormiston.

The Proposed New Cables.—Alderman Hadley, of the American, British, and Canadian Cable Company, left America for England on the 1st. According to the latest issue of the New York *Electrical World*, the alderman said—"Upon my return to England we intend to make immediate arrangements for the full completion of the entire system, and shall proceed by laying a cable from Penzance to Sable Island, and from that point to Halifax. At the latter place we shall be connected with the entire telegraphic system of the Dominion of Canada, and by a favourable arrangement just completed with the American Postal Telegraph Company, we shall have direct communication throughout the United States. Our cable will be about 2,700 miles long, and more direct than any at present existing. Eventually the company will have a cable running to New York. The capital stock is 1,500,000 dols., and the greatest share of it is already subscribed. The new cable will be a few hundred miles shorter than the others; but it is our system of operation that will enable us to transmit messages rapidly and at very cheap rates."

The Vienna International Electrical Exhibition.—This exhibition was opened, with great ceremony, on Thursday morning of last week by the Crown Prince Rudolph, who was accompanied by the principal members of the imperial family. After Baron Erlanger, the President of the Exhibition Commission, had thanked the Crown Prince, and through him the imperial family, for their patronage and support, his Imperial Highness, after dwelling upon the great importance of the future of electricity, pointed out that it was perhaps not mere chance that had caused the third but greatest electrical exhibition to be held within the hospitable walls of Vienna, and referred to the renowned inventions originating in Vienna. His Imperial Highness said that the exhibition did honour to the empire and to Vienna, and expressed his thanks to the friendly states for their valuable co-operation. The Crown Prince then, in the Emperor's name, declared the exhibition open. Lord Sudeley, Sir William Siemens, Sir Frederick Abel, and Captain Armstrong, who represent the English Government, regret that the English section compares so ill with that of France, Germany, Austria, and even America. Except a small pavillion in the Rotunda, where the English Commissioners meet, and about a dozen telegraph apparatus, there is scarcely any English exhibit visible. Sir William Siemens, however, promises yet to add to the British section a number of interesting scientific apparatus. The siphon recorder, of Sir William Thomson, and the Eastern Telegraph Company's large graphic map were inspected with the greatest interest by the Crown Prince Rudolph and his illustrious suite. Although opened sixteen days later than was intended, the exhibition, like its predecessors, is still incomplete. We shall probably have more to say on this subject in our next issue.

The American Telegraph Operators' Strike.—The New York *Electrical World* of the 4th inst. states that the telegraph companies still maintain an obstinate and invincible front, and the operators still hold the forts of the Brotherhood secure. There have been some defections from the ranks, as might have been expected, considering the immense number of men engaged in the strike throughout the country; but, on the other hand, many have joined the strikers, and altogether the operators have furnished an example of unanimity of action and unbroken determination unequalled by any other body of men. There have been no disorderly incidents to record, no weak complaints at the long delay, no childish repining, and none of that baneful disease known as discouragement, which has such a disintegrating effect upon united bodies. Complaints have been made by the Western Union Company that their wires are being cut. This rumour, the operators assert, is being circulated to turn the tide of public sympathy against them. Some even declare it to be their belief that the company is cutting its own wires in order to have an excuse for its delays in the transmission of dispatches. A later New York telegram states that the Brotherhood of Telegraphers having officially ordered a cessation of the strike, the operators on Saturday last applied for work all over the country. Many were rejected. The railway men of New York refused to obey the order, and are still out. The *Standard* says:—The collapse of the strike of telegraph operators in the United States is another instance of the impossibility of labour defeating capital. This attempt of the telegraph clerks in America to dictate their own terms seemed to offer far better chances of success than do strikes in general. This, however, has not been the case; and now that the Committee of the Brotherhood of Telegraphists have given permission to its members to return to work, many of them find that their ser-

vices are not required. The companies have discovered that there are a considerable number of railway and other clerks who, although not perhaps accomplished telegraphists, are able to work the instruments, and, having accepted their services in the hour of need, they will not turn them off to accommodate their late *employés*.

The Electric Carbon, Storage, and Apparatus Manufacturing Company of Scotland, Limited.—With a view to taking combined action, for the efficient protection of the rights of creditors, in the matter of the proposed liquidation of the above company, all such creditors are particularly requested to forward without delay their names and addresses to H. Alabaster, ELECTRICAL REVIEW Office, 22, Paternoster Row, London.

The Pilsen-Joel and General Electric Light Company, Limited.—In our last issue we alluded critically to the statement of accounts and report of the directors, and the affairs of this company. The report of the meeting, published herein on page 148, contains practically the chairman's reply to our criticisms. We admit frankly that his speech gives one a little more hope for good times coming than did the figures and remarks contained in the document previously issued. Wishing, however, as we do, all success to this and all other honestly-worked electrical companies, we do not feel satisfied that suitable arrangements have yet been made for conducting the business arrangements of such a company. Of Mr. Dunstan, whose name is mentioned in the report of the meeting, we know nothing one way or the other, and therefore we presume that we shall not be mistaken as directing our remarks at this gentleman's recent appointment. With regard to Mr. Joel's new position as consulting engineer, why does the company expect to benefit by consultations with him when it had ceased to consult him, for some time past, whilst still filling the position of chief engineer? There is an apparent absurdity, at least, in this part of the chairman's remarks. We notice also that the chairman and one of the directors act as a committee at the factory. If by the director the managing director is intended we think, that from all the evidence before us, including the chairman's own speech, as to the many difficulties of carrying out the commercial (as apart from the factory) work of the company, that it would be more profitable if the managing director gave his *undivided* attention to such work rather than occupy his time in mere details of factory operations. When next a report of this company is issued we trust we shall find that the fulfilment of our predictions may, by good generalship, have been completely averted.

NEW COMPANY REGISTERED.

Continental Maxim - Weston Electric Company, Limited.—Capital £500,000 in £1 shares. Registered office, 47, Cannon Street. Object: To supply electric light and power upon the continent of Europe, and for such purposes to enter into a contract with Hiram Stevens Maxim, Edward Weston, and Nicholas de Kabath. Signatories (with one share each): S. Gray, 3, Upper Avenue Road, N.W.; H. S. Maxim, 137, Plough Road, Clapham Junction; *N. de Kabath, 47, Cannon Street; *Hugh Watt, 93, London Wall; J. Brown, 3, Aubrey Road, Holland Park; J. B. Cox, 93, Leadenhall Street; W. R. Blogg, 229, Gresham House. Victor D'Ofenheim, of Vienna, is appointed a director, the other members of the board being the signatories against whose names an asterisk is prefixed. Directing qualification, fifty shares; remuneration, £2,000 per annum, and in addition thereto 5 per cent of profits remaining after the payment of an annual dividend of 6 per cent. Registered 16th inst. by Paines, Layton & Pollock, of Gresham House, Old Broad Street.

* Those signatories whose names are preceded by an asterisk are also directors.

OFFICIAL RETURNS OF ELECTRIC LIGHT COMPANIES.

Electric Carbon, Storage, and Apparatus Manufacturing Company of Scotland (Limited).—This company, being about to wind-up under somewhat exceptional circumstances, a brief *résume* of its history, compiled from the official records at Somerset House, may be of interest to our readers. The company was registered on the 9th of May, 1882, with a capital of £150,000, in £1 shares, to carry out an agreement of the 28th of April, 1882, between Messrs. Hope & Co., merchants, of Leith, and Wm. Plenderleith Hope and John Wilson Hope, the partners in that firm, of the first part, and Edward Mather, engineer, of Edinburgh, for the company of the other part, for acquiring certain premises known as the Sugar House, situate in Coburg Street, Leith, with machinery, &c., and together with 390 fully paid shares in the Electrical Power Storage Company of London (Limited). The purchase consideration was £15,000 cash, and £7,500 by the issue to the vendors of 15,000 shares paid up to the extent of 50 per cent. Power was taken by the company to carry on in England, Scotland, or elsewhere every kind of business directly or indirectly associated with the use or employment of electricity, galvanism, magnetism, or similar agencies. The agreement referred to was modified by a subsequent agreement, registered on the 5th July, 1882, under which the vendors purchase from the company the 390 fully-paid shares referred to, for the sum of £5,000, that amount being deducted from the £15,000 payable in cash. The statutory return of the company, made up to the 30th August, 1882, was not filed until the 5th February, 1883. This return showed that 27,517 shares had been taken up, and a call of 10s. had been made thereon, the total calls paid amounting to £13,027, leaving £731 10s. unpaid. The following is a list of the largest shareholders:—A. Ainslie, Dalkeith, 400; E. Whitton Bradley, Birmingham, 200; J. E. Brock, Kirkleston, 200; G. B. Bryan, Stockport, 200; J. Cran, Inverness, 200; J. G. Davidson, C.E., Ardishaig, Argyll, 300; J. Dalrymple, Edinburgh, 200; J. D. Fraser, J.P., 300; H. Gilmour, Edinburgh, 200; J. Wilson Hope, Edinburgh, 1,000; F. M. Haldane, Leith, 200; W. Plenderleith Hope, J. Wilson Hope, B. Wilson Hope, and J. A. P. Hope, all Leith, 14,400; H. Knoblanch, Leith, 200; R. Lockhart, Edinburgh, 300; J. Lyon, Edinburgh, 250; T. Lonsdale, Edinburgh, 400; J. Murray, Stirling, 400; E. Mather, Edinburgh, 500; J. Dick Peddie, M.P., 400; W. Paddon, Okehampton, 200; D. R. Ratcliffe, J.P., St. Alne, Warwick, 300; E. O. Wollaston, Bournemouth, 500; G. M. Wood, S.S.C., 250; W. Whyte, Edinburgh, 200; D. J. Wilson, Kirkcaldy, 200. The registered offices of the company are at Dashwood House, New Broad Street, E.C.

CITY NOTES, REPORTS, MEETINGS, &c.

The Pilsen-Joel and General Electric Light Company, Limited.

The second ordinary annual general meeting was held at the Cannon Street Hotel, on Wednesday, Sir Rawson W. Rawson, K.C.M.G., C.B., the chairman, presiding.

The Secretary (Mr. E. T. Gregory) read the notice convening the meeting, and the director's report, which we published in our last issue, was taken as read.

The Chairman said:—Gentlemen, I do not think that the report and accounts, which are so full and explicit, need much detailed or lengthened observation from me. There are, however, two or three things that I desire to bring specially under your notice, and in doing so I shall not occupy much of your time. The first and most material of these is, of course, as to the necessity for the call that the directors are making upon the shareholders. You will remember that this company was formed under very different circumstances from those under which it was brought into actual operation. When the prospectus was issued the directors had an expectation, amounting to an assurance, that they would derive from the sale of the concessions of their patents, both in the United Kingdom and in the colonies, an amount of capital which would enable them to carry on their manufacture and their operations without pressing upon their shareholders in any way. They therefore, as I mentioned when I last had the honour of meeting you, instead of calling for £3 a share upon the allotment, reduced the amount to £2, and they had the expectation then that whenever the company was called upon to supply

electricity in a town or district they would derive that aid from their auxiliary companies which would suffice to carry on their operations. However, as you know well, circumstances changed almost at the moment of the birth of the company. The expectation of an early sale of concessions was deferred. There was a revulsion of public feeling with regard not only to electric lighting companies, but with regard to electric lighting generally, and the action of Parliament, wise as it may have been, and wise as we believe it has been in the interests of the public, was a necessary check upon the operations of the several electric lighting companies. We have struggled during the past year against all the difficulties which we, as well as other electric lighting companies, have experienced. We proceeded in the confidence that we possessed, in our patents of our Pilsen and Gatehouse lamps, articles which would stand the brunt of competition—which would survive whilst others less effective fell to the ground; we, therefore, had no hesitation in prosecuting our enterprise. We did not start originally with the idea of being mainly a manufacturing company, and therefore our capital was fixed at an amount less adapted to extensive manufacturing purposes than to the possibility of deriving from auxiliary companies the means of developing our patents. That expectation has, however, been postponed. We have not abandoned the hope that when the desire to possess the electric light, which is daily increasing, shall become general, when our colonies shall have the opportunity of testing the value of the several lights in the United Kingdom, we shall find a large market for our property in the colonies, and a demand for concessions which we already have in negotiation with an expectation of being eventually carried out, and that our property will realise what we had first hoped, but which up to the present moment has been deferred. We have carried on under great difficulties during the past year, and we think that we stand in a position as good as any of the younger companies formed for the same purpose as ourselves. We cannot boast ourselves in the position of companies which are two and three years our senior, which embarked large capitals in enterprises, and had the start of us, and which had possession of the field before we came into existence. That has been necessarily one of our difficulties—that during the past year Great Britain had been covered by the auxiliary branches of companies existing before we were created—and a subsequent difficulty has been that we have had to compete with companies which, under peculiar circumstances to which I need not refer, have pressed the sale and the use of their dynamos and lamps on terms with which neither this company nor any other could profitably compete. We have also had, not a difficulty, but a necessary delay, in improving the quality of our several forms of manufacture, not that it was necessary to improve, but that we could improve it, and we therefore have been aiming at improvement, and with success. Every one of our lamps are of better manufacture, and our dynamos more efficient than those of the original form. We have also been occupied, as you are aware, and as our report states, more particularly during the last three or four months, in completing new forms of our manufacture. A cheaper arc lamp was not only a *desideratum*, but an absolute necessity. For certain purposes the present arc lamp—excellent as it is—is considered too dear, and we have had it in view to construct a lamp of equal efficiency but in a different form, and at a cheaper cost. And in that we have been entirely successful. We have also had the difficulty during the past year of perfecting an incandescent lamp. As the prospectus announces to our shareholders, the Gatehouse incandescent lamp was not in perfect form when we bought the patent. Since then the manufacture of incandescent lamps has so advanced—has so much improved—every one of the companies has so greatly improved its incandescent lamps that if it had been perfected at that time we should have had to improve it to carry on a fair competition with our rivals. We believe we have now attained that object—we believe that our incandescent lamp, as regards the economy of its working, and as regards the probable duration of its life, will compete with any of the most favourable forms of incandescent lamps now in the market. Another great object with us has been to complete our incandescent dynamo machine. The original dynamo, which was excellent for arc lighting, was not adapted to incandescent lighting. We have had, therefore, so to adapt it, and we have succeeded in adapting it, so that we are now in a position which we have not been in up to the present time, of supplying, we believe, not only the best arc lamp in the market, but we can now supply an incandescent lamp as good as any other, and an incandescent dynamo, which we did not possess up to the present time. Therefore our year, though it has not been spent in producing much, has been spent—advantageously spent—in preparing the means of profitable exploitation of the company's affairs during the coming and future years. Upon those grounds, which have been already stated in the report, which has been in your hands for several days, and which you have had an opportunity to examine, we believe we are justified in saying that the prospects of the company are encouraging, and that we have laid the foundation for a profitable business. To those who are familiar with the manufacture of electrical apparatus, who know the enormous difference between the construction of an ordinary piece of mechanism and an electrical machine, who know that although you may have perfect mechanical construction of the parts, yet that the subtlety of electricity is an invisible and a most capricious (as far as we yet know) element, forms a very important part in the successful construction of a machine, will well understand that there must be delay and expense in the successful manufacture of a new form of electrical apparatus. To them, therefore, it will not be a matter of surprise that there has been the delay and the expense in perfecting our several forms of manufacture. And to those who have watched the proceedings of other companies, and have studied their reports and their accounts, it will be apparent that the amount of time and the amount of money expended by this company is not to be compared with the amount of money and of time that have been expended by other companies in attaining the same results that we have now reached. Whilst, for instance, the cost of perfecting the Lane-Fox light may be measured by tens of thousands of pounds, whilst it has taken years of thought and labour to produce an Edison incandescent machine, the results which we have obtained (which we confidently believe we have obtained) during the first year of our existence, will, I think, deserve the congratulation of our shareholders. The sum expended has been comparatively small; the time has been equally small. That, I think, is sufficient with regard to the past. The report will speak for itself as regards the future. There is one point I cannot pass over, which is the success of the company with regard to the Provisional Orders for which it applied. The only Order in which it persevered, for reasons which the report explains, was passed without opposition both before the Board of Trade and in the Houses of Parliament, and we hope it will soon become an Act. In regard to the other two Orders, although we did not persevere in them, it was simply because the local authorities were desirous to obtain Provisional Orders for themselves, and were prepared to give us the areas which we had applied for as soon as they obtained their own Provisional Orders. It is an advantage, therefore, for us to work with those Boards, and to obtain their assistance, which we probably shall, financially as well as morally, and therefore we consider it a success to stand in the position in which we do with regard to them. There is one matter I now desire to bring before your notice, and that is, that two attempts have been made lately to injure the credit of the company, and if possible to drive it into liquidation. (Hear, hear.) These attempts have happily been defeated. I do not wish to say anything that may excite any acrimonious feeling with regard to the fact. I would rather that those who attempted to injure us, finding that they had failed, should work with us, and that we may all work together for the advantage and success of the company; but I must say that the action of the petitioners for the winding-up of the company has been sufficiently exposed by the publicity given to the circumstances under which the petition and its authors have been represented, and by the dismissal of the petition with costs. The directors consider it unfortunate that they had no opportunity of challenging and disproving the allegations in the affidavits made in support of the petition. The petition was withdrawn at the last moment, although that very morning, or the previous afternoon, an additional affidavit was brought forward by the petitioners. They were, therefore, up to the last moment prepared to defend their petition, and at the moment of the case coming on they withdrew it. The directors, as I say, are sorry that they had not the opportunity of publicly challenging and disproving the allegations of the petition, and showing its unjustifiable character. Having lost that opportunity, they deemed it desirable in the interests of the company to obtain the opinion of the eminent counsel (Mr. Higgins) who conducted their case as to the character of the allegations brought forward in the petition, and that eminent counsel has given his opinion that there was no justifiable ground whatever for the petition, that it was not a *bonâ fide* proceeding in the interests of the shareholders, that it was intended as an attack upon the company, and that an action would lie against the petitioners for their unwarrantable and unjustifiable attempt to injure the company. This opinion is now under the consideration of the directors, and certainly if it is necessary for us to defend the interests of the company by bringing an action against the petitioners, or against any others who make a similar attempt upon equally unjustifiable and futile pretences, the directors will, in the interests of their shareholders, not fail to act and to prosecute to the end. It has been satisfactory to the directors, and it doubtless must be satisfactory to the shareholders, to see the determination of the judges to protect public companies against such attacks. We may hope that the view taken by the judges is that the views of a minority, not supported by facts and not capable of proof, cannot and ought not to command the ears of the judges, and that they will not entertain attacks of this nature, and will punish such petitioners by dismissing their petitions with costs. You cannot wonder that attempts of this kind have during the last month or six weeks seriously prejudiced the company. Two contracts at least have been delayed in consequence of this attempt. Naturally no parties would enter into a contract with a company which has a petition of this kind hanging over it, and therefore it is of such consequence to the company that the directors are determined to do their best to prevent the repetition of such an occurrence. I am happy to tell you that within the last three days a very important contract with an important department of her Majesty's Government which had been nearly completed before this petition was filed, and the completion of which was held back until the decision of the Court was known, is now in process of completion. Inquiries with regard to our lights, in the expectation of successful and valuable contracts, are readily coming into the Board. So far, good may come out of evil. The evil you know; the quality and excellence of the wares that the company has to offer have attracted a notice which a number of expensive advertisements might not have succeeded in doing, and we really hope that we may derive an advantage from what has taken place; but it is too dangerous a matter to be allowed to be repeated, if we can prevent it. I hope nothing of the kind will again arise, and that this

year we shall be enabled in quiet successfully to develop the affairs of the company. The directors have during a year of great discouragement and great difficulty, together with a most unfavourable season, prosecuted your affairs with a single eye to your interests. They are largely interested themselves in it, that is true, but they are not at all largely interested in remaining directors; their sole interest is to prosecute the affairs of the company with a view to your interests. They have avoided any extravagant enterprises—any extravagant purchases of patents—any extravagant or expensive or unremunerative exhibitions; they have not involved the company in a single legal difficulty; they have not made a bad debt, and they have kept the company entirely out of debt. The company now possesses a property which is capable of being developed with profitable results, and I trust that the shareholders present, having studied the report and accounts rather than anything that I have said or could say, will be prepared, by adopting the report, to testify their continued confidence in the honesty, industry, and care on the part of the directors concerning their interests. (Applause.) There is one point the secretary has called my attention to. I really felt rather reluctant to refer to it, because it affects the directors themselves. You may have seen in the accounts that the directors, who have been in charge of your affairs for now fifteen months, and who are entitled to draw during that time fees to the extent of £1,600 odd, have drawn less than £1,200. The explanation of that is that, when the funds of the company in the month of April fell short, the directors felt that they ought to economise in every way they could, and decided that, until the affairs of the company were more prosperous, their remuneration should be deferred, and, therefore, with the exception of a comparatively small amount drawn by the chairman and one of the directors, who acts as a committee at the factory, the directors have not drawn their salaries, but have deferred them. It seems that in the accounts that item is not included in the liabilities, and, therefore, it is right that I should mention to you that if the affairs of the company flourish in the ensuing year they are confident you will not begrudge them the amount which you originally awarded them under the articles of association. With these observations, I propose—"That the directors report and accounts, as published, be, and are hereby, received and adopted."

Major-General Hopkinson, C.S.I., seconded.

In reply to the questions and comments of shareholders,

The Chairman said, as regarded a committee of consultation, which had been suggested by Mr. Morton, if such were appointed it would simply renew in a mild form the attempt made six weeks ago to have a committee of examination, and the results in his opinion would be equally disastrous to the interests of the company. Their company was one of the first which was asked to send its lamps to the Fisheries Exhibition. It was, however, to do it without any remuneration, and without any satisfactory evidence that the lamps would be shown to advantage. The directors therefore declined to exhibit there. As to agents, they had agents in three or four or more of the principal towns in England, and the directors, now being in a position to receive orders, and to satisfy them, were occupied with the appointment of agents. If, however, electric lighting became what they believed it would, they should not want agents; the orders would come in without them. The directors were quite satisfied with the present electrical engineering arrangements in their factory. They believed more had been done within the past three months than at any previous time in the advancement of the new forms of manufac- which depended upon the assistance of the electricians. Mr. Joel was now their consulting engineer. He was some time ago engineer of the factory. He resigned that office in April. He was now, he (the Chairman) believed, working in the interests of the company in every way. The manager was Mr. Dunstan, who was employed by the Brush Company. He had had experience of electrical and general engineering. The directors were satisfied with the progress made in the factory in the perfection of their different forms of manufacture. The £5,690 set down in the accounts as "expenses of experimenting and perfecting lamps and dynamo machines, making patterns, &c., &c.," had not been expended in improving their stock at all, but had been incurred in the early stages of their manufacture, and in the subsequent experimenting upon new forms.

The report and accounts were unanimously adopted.

Messrs. Broom, Hays, and Akers were re-elected auditors for the ensuing year, the remuneration being fifty guineas.

A vote of thanks to the chairman and directors closed the meeting.

The Electric News-Telegraph Company (Limited).

THE first annual meeting of the shareholders of the above-named company was held on Monday last, at the Salisbury Hotel, Salisbury Square, General Sir Michael Kennedy, K.C.S.I., presiding.

The Chairman, in moving the adoption of the annual report, said that when the directors last had the pleasure of meeting the shareholders they had then looked forward to be able on this occasion to have given more cheering information. He regretted that in the past year's working the company had incurred a loss, but the fact had to be looked at boldly, and the causes that had led to this examined. In his opinion these causes were temporary and passing, and he was satisfied that with perseverance and courage they would be able to get over their present difficulties. When he last addressed them he referred to the keen competition that met them on their first start, and that endeavoured to strangle them before they even saw the light. Well, it had not ended there, and their infancy was not allowed to pass without renewed efforts to destroy them. An older and rival company had left no stone unturned to crush them, but as yet only with the effect of retarding—not stopping their progress. As stated in the report before the meeting, the company commenced with 79 subscribers, and at the date of the report they had 177 subscribers, and but for the causes he had alluded to, they would have had many more. Since the date of their report, that was within the last 10 days, they had obtained nine additional subscribers, making up a total at the present moment of 186. To enable the company to hold its own with an opponent who had strived to cross them at every point, and ready to make any sacrifice so long as injury could be done to them, they had been compelled to reduce their charges, and had been obliged to incur a large and, under ordinary circumstances, he thought a needless expenditure in obtaining and transmitting news with great promptitude. The only consolation, if it be one, was their rivals while endeavouring at all risks to injure them, had greatly hurt themselves, and the shareholders of the Exchange Company had cause to complain of the wasteful and senseless policy adopted by their directors, which had brought disaster upon the interests committed to their charge. They had not been able to obtain a report of the Exchange Company's general meeting held a short time since with locked and closed doors, but their condition was not easy to conceal, and it had leaked out that instead of a dividend of 10 per cent. on preference, and 1½ per cent. on ordinary shares, as declared hitherto, they had been unable to declare a dividend on either. Further, that their profit and loss account, as made up, admits a nett loss of about £1,400, that their reserve fund of about £3,800 had been drawn upon to cover a further loss of about £2,200, whilst the number of subscribers they now had was actually less by some 40 or 50 than it was last year. The nett loss of the Exchange Company had probably not been less than £10,000. Like sensible and business-like men the directors of this company had approached their opponents, and had pointed out how they were inflicting mutual injury on each other for the benefit of others, and they had shown how they could work together with the most manifest and immediate advantage to both. These facts had not been controverted, they were beyond dispute, but it was apparently held that the Electric News Company could be got rid of entirely, and the road cleared for a monopoly. But their rivals were mistaken, as he thought the facts he had shown the meeting would assure them that while they had gradually been gaining strength, their opponents had been as steadily losing it. Their game was a waiting one, and it must succeed, but in the meantime they must, while not relaxing their efforts, be prepared for some present sacrifices, be patient and be confident. Another cause which had told against them had been the action of the Post-office, which for some departmental reasons, quite unconnected with them, had refused to extend their system of wires, and had thus prevented them getting many new subscribers; but this difficulty, though bringing with it some present inconveniences, was not an unmitigated evil, for it had forced them to depend upon themselves, and to make efforts to carry on their business by means of their own wires. They had for some time been aware that it would be to their great advantage to do this work themselves, but they had not till lately been prepared to take it up, and it was with a view to carry it on with the greatest vigour that they would have to ask the shareholders for power to raise the needful capital by the issue of a limited number of preference shares. With regard to the sale of their patents, he was unable to say much at present, they would possibly have more information in a month or so, and they would not delay in communicating the result to the shareholders. In conclusion, he begged to move that the report and accounts be received and adopted.

Major Charter seconded the motion, which, after some questions had been asked by one or two of the shareholders present and replied to seriatim by the chairman, was put and carried unanimously.

Messrs. Good, Daniels, & Co. were re-elected auditors to the company.

The Lancashire and Cheshire Telephonic Exchange Company Limited.

THE second ordinary general meeting of the shareholders was held on Monday, at the office of the company, Faulkner Street, Manchester, Mr. Charles Moseley (the chairman) presiding. In the annual report (which was taken as read) the directors stated that at the last annual meeting the hope was expressed that the coming 12 months would bring new business to the amount of £10,000. This estimate had been exceeded, and the gross increase was nearly £12,000. The total income (including orders not completed and for which payment had not been made) on the 30th June, the close of the financial year, was £54,498 3s. 8d., as compared with £42,817 17s. 11d. last year. The gross rentals applicable to the year's revenue (including the out districts) amounted to £45,544 12s. 2d., against £27,227 5s. last year. The total number of subscribers to the exchanges on June 30th, 1882, was 1,740, and of private renters, 472; this year to the same date the number of subscribers was 2,359, and of private renters 697. The amount standing to the credit of the profit and loss account was £15,203 4s. 6d., out of which the directors proposed to declare a dividend of 5 per cent., which

would absorb £13,000, leaving a balance to be carried forward to next year of £2,203 4s. 6d.

The Chairman, in moving the adoption of the report and statement of accounts, said that at their last annual meeting considerable doubt existed as to whether the patents and the monopoly of the telephone would be maintained. Since then there had been a large amount of money spent by the present company, and the matter of the validity of the patents had been carried to the Court of Appeal, the result being that the position of the holders of the patents had been clearly defined, and it was established that they had in their hands the absolute monopoly of the telephone for the remaining term of the patents. They knew that there were rumours at various times of new instruments that were to be thrown into competition with that company. and the shareholders were too apt to take cognisance of reports which were spread abroad by various interested parties to the effect that a new instrument had been discovered, and that the company would have serious competition in their district. This, as they knew, had been threatened for a long time; but "threatened men live long," and he thought they were in a safe position. As far as science had gone at present, no step had been taken as yet with regard to anything that would supersede the telephone, and he had no doubt that they would have, until their monopoly ceased by reason of their patents lapsing, the entire control throughout the districts which were granted to them in their licences, and they could not therefore but anticipate that they should have a constantly increasing business. They would observe from the balance-sheet that their income had increased from £42,817 to £54,498, leaving them a net profit of £15,203. Out of that gross income they had to carry forward £23,391, which was received in anticipated rentals, as against £15,590 last year. It might strike some shareholders as singular that with so largely an increased income they had not a larger surplus of profit to divide, but it must be remembered that the balance of last year, which enabled them to pay a 5 per cent. dividend, included a sum of £8,000, which was derived from the sale of instruments by the company, so that they had a considerable increase in their profits as compared with last year. There was one important feature to note, and that was that they had debited £6,645 as the cost of maintenance and renewals, but there was a very pleasurable fact in connection with that expenditure, and that was that the cost of maintenance proportionately to their income was slowly and surely reducing itself. They had during the year been subject to very severe losses, the whole of which had been debited to maintenance. They had in December a very heavy storm—such a storm as had never before been experienced in the recollection of the Post Office. It was a curious combination of rain, frost, snow, and whirlwind, which seriously damaged the wires, and involved the company in a dead loss of £1,500. They had, after careful consideration, determined to debit that loss to the current year. They had also suffered a loss of £500 by the removals of standards upon buildings which had been pulled down. At first they were content to get standards wherever they could, but now they were fixing their standards upon buildings that were not likely to be removed. Again they decided to debit that loss to the year's revenue. They had further incurred a loss of £700 in connection with the trunk lines, and this, too, had been debited to the present year. The engineers had rendered an account of the work they had done, and he found that all was reported as being in excellent condition. A large number of wires had been renewed and replaced, a great number had been diverted and concentrated into systems of trunk lines. Their mileage of wires had increased from 1,819 in 1882 to 2,950 miles in 1883. The number of calls that had been made, or messages that had passed along the wires, during the year in Manchester was 7,285,846, and in Liverpool the number was 1,082,166. This showed that the adoption and use of the telephone was becoming more general, and it was appreciated in every direction; and he thought they would agree with him that when such a large number of messages were passed through the system, it spoke well not only for the excellence of the instruments but also for the management that could cope with such a large number of messages. Some of the large merchants in Manchester sent as many as 50 or 60 messages per day. The average speed of communication between subscriber and subscriber was 32 seconds, whereas the reports they had from New York, where, being the home of the telephone, they should naturally look for perfection, showed that their speed was 60 seconds. Many complaints had been made by subscribers that they could not readily get communication with the subscriber they wanted, and it had been found that invariably this arose from want of attention on the part of the subscriber who was "called up." He hoped that there would be more promptitude shown in the future, for if the subscriber who was wanted would pay more attention, and answer directly the bell rang, a vast amount of trouble would be saved. It might possibly suggest itself to subscribers that the directors had made no allowance for the depreciation of their plant. They must bear in mind, however, that they had expended in maintenance and renewal of their system £6,645, and that practically amounted to depreciation. As a wire wore out they fixed a new one; as an instrument got defective they repaired it, and the whole of the cost of these repairs and renewals appeared in the maintenance account. He did not think there was any necessity whatever to consider the question of depreciation, for the renewal of their plant, and the fact that their engineers reported that the whole of the plant was in good working order, should be a sufficient guarantee to the shareholders that the depreciation was compensated for by maintenance. They had completed their arrangements with the Post-office authorities, who had conceded them the unrestricted right to effect connections between the various towns in the district upon certain conditions. He could only refer to their relationship with the Post-office in the most grateful and cordial terms. The directors were of opinion that, in consideration of increased services and advantages offered to the subscribers, it would shortly be necessary to increase the amount of the annual subscription. When the present rate was fixed at £20 a subscriber was only able to communicate to perhaps 200 other subscribers, whereas he could now speak to nearly 1,000. In America the smallest rate of subscription was £24, and in New York the amount was £42. (Applause.)

Mr. Eli Heyworth (Blackburn), deputy-chairman, seconded the motion.

Mr. Agnew, M.P., said that, with regard to the remarks of the chairman as to increasing the rate of subscription, he begged to point out to the directors that, whilst in no sense impugning their judgment in the matter, it was always a dangerous policy to increase prices. The directors should take into consideration the possibility of the event of their raising the rate leading to a falling off in the number of subscribers. He apprehended it would be more than a doubtful policy—it would be a fatal policy for the company to raise the rate if the parent company continued its subscription at the present amount.

The motion was carried.

On the motion of the Chairman, a dividend of 5 per cent., free of income-tax, was declared payable forthwith.

The retiring directors—Messrs. F. W. Reynolds, G. H. Robertson, and Alderman Thompson—were re-appointed. Mr. C. R. Trevor was re-elected auditor.

A vote of thanks to the chairman closed the meeting.

The Anglo-American Brush Electric Light Corporation (Limited).

THE following circular has been issued to the shareholders of the above corporation:—"Sir, I am desired by my directors to acquaint you, that at their last board meeting, held yesterday, it was resolved to make a call of £1 per share on all shares of this corporation not fully paid up.

"Since the recent re-construction of the board, sufficient time has elapsed to enable the directors to consider in all its aspects the position of the corporation, and they are glad to be able to state that they regard it as a thoroughly sound one. On the other hand, the directors found themselves confronted with an establishment much beyond their then working requirements, with large outstanding contracts for materials, entered into by the previous management, and with heavy stocks of manufactured goods, greatly in excess of the diminished demand consequent on the stagnation of electric lighting generally.

"The directors lost no time in applying to this state of things the only remedy at their command, namely, reductions of staff, of establishment and of expenditure, in all departments, wherever possible, without prejudice to the power of production and expansion, and keeping in view the prospect of a sudden reaction and renewed activity of business.

"That this day will shortly come, they cannot doubt. The greater number of the Provisional Orders for electric lighting sanctioned by the Board of Trade have been practically accepted by Parliament, and cannot fail to create a large and speedy demand for electrical appliances.

"On review of all the circumstances, the board was, therefore, unanimously of opinion, that it would be a wise policy on their part to take steps to place the corporation in such a position as to be able to take the utmost advantage of the favourable moment for action when it occurs. The decision to make this call has not been arrived at without mature and anxious deliberation, and it is one in the propriety of which they believe you will fully concur.

"I am, Sir, your obedient Servant,

"E. GARCKE, *Secretary.*

"112, Belvedere Road, Lambeth, London, S.E.,

"11*th August*, 1883."

The Hammond Electric Light and Power Supply Company (Limited).

THE directors of this company resolved, at their meeting held on Thursday of last week, to make a call of £2 10s. per share, payable £1 5s. on the 21st September and £1 5s. on the 1st January, 1884. The Secretary, Mr. P. A. Latham, in giving formal notice of this call, in a circular, says:—"In spite of the persistent reports to the contrary, lighting by electricity has this year been gradually gaining in public favour; and, on the threshold of another lighting season, the directors are confronted with so many applications for installations on hire that they see prospects of employing very profitably the share capital which, hitherto, they have refrained from calling up. The Provisional Orders just granted by Parliament open out a very wide field for those electric lighting contractors who, during the past few years, have kept themselves abreast of all the developments of the new science, and the directors of the Hammond Company feel justified in saying that, with their extremely competent electrical staff, assisted by cadets from the Hammond College, the vitality of which is unflagging, they are able better than any other company to carry out electrical work on a large scale on behalf of corporations, local electric light companies, &c., &c.; but, to obtain

these contracts and to carry them out, a strong backbone of capital is necessary. In order to have a good district completely under its own control, the company have promoted, and carried through Parliament, a Provisional Order, drawn in favourable terms and on a sound commercial basis, for supplying Hampstead with electric light, under the provisions of the Electric Lighting Act, 1882. Part of the money now called up will probably be used in carrying out the requirements of this Provisional Order, in partnership, or otherwise, with capital locally subscribed by those householders in the district who may be desirous of having the light introduced into their mansions, and who prefer to put their money into a local company, which will supply the 'current' from a 'central station,' rather than invest it in plant working on their own premises. The directors desire to take this opportunity of informing the shareholders that the managing director, Mr. Robert Hammond, has just returned from a visit to the United States, and without going more into detail at the present moment as to the object of Mr. Hammond's journey, it may be stated that it is not improbable that some portion of the capital now called up may be judiciously and profitably employed, not in buying, but in working an American patent, which will, it is believed, have a marked influence in cheapening the supply of electric light. In conclusion, the directors are anxious to emphasise the fact that the call of the remainder of the share capital of the company is for the purpose of providing a strong reserve to cope with new business of a sound and highly remunerative nature.

The Eastern Telegraph Company (Limited).—This company notifies the restoration of the Foochow-Shanghai cable. Telegrams are now arriving from Foochow and Shanghai by this company's route with their customary regularity.

The Eastern Telegraph Company (Limited).—This company notifies the repair of the Hong Kong-Amoy cable, thus restoring communication *vid* India with Shanghai and other stations in China.

TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Letters, &c., for the "Correspondence" columns should arrive not later than Tuesday morning if they are desired to appear in the following number, such communications to be addressed to the "Editors," ELECTRICAL REVIEW, 22, Paternoster Row, London, E.C.

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CORRESPONDENCE.

Electrical Boats driven by Batteries.

I herewith forward you a few notes and observations with reference to the above.

On Friday last, I made a short trip from Hammersmith Bridge to London Bridge in the *De la Motte*, which was accomplished at the rate of one mile in 11 minutes; afterwards returning to Hammersmith. The distance would be for the course we had to take, partly against the tide on the return journey, some 20 miles.

Dimensions of the *De la Motte*, 21 feet long by 3 feet 6 inches; midship nearly as wide at the bottom as at the top.

Weight carried, 1,500 lbs.; displacement about 24 c. feet. This includes the weight of boat, "Patent Motor," battery (which was Bunsen's), and passengers, which latter weighed 508 lbs. Draught of water aft 15 inches, in midship 9 inches.

Propeller—This was one of Stevens & Smith's Patent "Tractrix," of Blackman Street, S.E., with an 18-inch pitch. It was driven at the rate of 256 revolutions per minute. It was connected directly on the shaft of the motor without any intervening gear, as specified for all electrically-driven machinery in my patent of July 7th, 1882, in these words:—"Without the use of any intervening gear, thus doing away with all unnecessary friction." I call particular attention to this, as I am now constantly reading of some of our friends connecting theirs in a similar manner, and putting some stress upon the fact as if it were new to them, which, by-the-bye, I have no doubt it is. It would be as well to tell them that if they also have their machinery fitted with roller bearings as mine is, or with friction rollers, it will still further diminish the friction, or, in other words, increase the effective power of their motors.

Cost of materials used—

3 lbs. of sulphuric acid, at 1d., sp. g. 1·8	3d.
2 lbs. of zinc, at 3½d.	6¼d.
3 lbs. of nitric acid, at 3½d., sp. g. 1·420	10½d.
Total	1s. 7¾d.

As ball bearings only require lubricating about once a week, I have omitted the item.

The best method of verifying these figures is to pass a current from the same number of cells (58) through a constant resistance of 13 ohms for the time specified, say 10 hours, and analysing the liquors.

Zinc. As some difference of opinion seems to prevail as to the cost of this metal, I may state that it is as above, or rather less, dependent upon quantity bought. The best "Vielle Montagne" zinc, doubled rolled in any requisite shape, 3⅛d. per lb., free in London.

I am now having built a new boat 32 feet long by four feet wide, with which I see no fear of making from six to seven miles per hour.

E. Toynbee.

18, Malvern Villas, Willesden,
August, 1883.

Resistance of Telegraph Wires.

Will you kindly let me know what is the resistance of a *circuit* of the Post-office telegraph wires, say per one mile, per 50 miles, per 100 miles, per 200 miles, 400 miles, 600 miles?

Inquirer.

[We hope our correspondent will find the following table with which we have been favoured, although not exactly what he asks for, sufficient for his purpose.—EDS. ELEC. REV.]

Gauge of wire.	Length of wire in miles and yards.	Section of circuit.	Total Resistance.	Resistance per mile.	Remarks.
No. 8	90·0	Carlisle to Preston	1530	17·01	Wet
" "	"	"	1550	17·23	"
" "	42·305	Carlisle to Kendal	960	20·63	"
" "	42·305	"	620	12·73	Fine
No. 4	"	"	402	7·35	"
" 8	85·1521	Manchester to Leicester	1200	13·39	"
" "	30·1274	Manchester to Liverpool	520	11·29	"